CITY OF CARMEL-BY-THE-SEA

FOREST AND BEACH COMMISSION

Chair David Refuerzo, Commissioners Karen Ferlito, Mo Massoudi, Stephanie Locke, and Al Saroyan

All meetings are held in the City Council Chambers
East Side of Monte Verde Street
Between Ocean and 7th Avenues

REGULAR MEETING
5/11/2017
MEETING 3:30 p.m.

CALL TO ORDER AND ROLL CALL

PLEDGE OF ALLEGIANCE

INTRODUCTION OF PUBLIC WORKS STAFF

Mike Tope – Maintenance Worker / Coastal Gardener
Jessie Garibay – Public Works Supervisor

PUBLIC APPEARANCES Members of the public are entitled to speak on matters of municipal concern not on the agenda during Public Appearances. Each person's comments shall be limited to 3 minutes, or as otherwise established by the Commission. Matters not appearing on Commission's agenda will not receive action at this meeting but may be referred to staff for a future meeting. Persons are not required to give their names, but it is helpful for speakers to state their names so that they may be identified in the minutes of the meeting.

ANNOUNCEMENTS

A. Announcements from Chair and Commissioners

CONSENT AGENDA Items on the consent agenda are routine in nature and do not require discussion or independent action. Members of the Commission or the public may ask that any items be considered individually for purposes of Commission discussion and/ or for public comment. Unless that is done, one motion may be used to adopt all recommended actions.

1. Approval of the minutes for the 04/13/17 regular meeting.

ORDERS OF BUSINESS Orders of Business are agenda items that require Commission discussion, debate, direction to staff, and/or action.

2. Report from the 2017 Arbor Day event committee.

3. Report on options for tree inventory data collection.

4. Receive the City Forester's Report
    a. April tree data
    b. Parks activities
    c. Beach activities
    d. Other items of interest to the Commission
        i. Illegal pruning
        ii. Petit project
        iii. Tree watering and planting

FUTURE AGENDA ITEMS

ADJOURNMENT

This agenda was posted at City Hall located on Monte Verde Street between Ocean and 7th Avenues, Harrison Memorial Library located on the NE corner of Ocean Avenue and Lincoln Street, and the Carmel-by-the-Sea Post Office located on 5th Avenue between Dolores Street and San Carlos Street, and the City's webpage http://www.ci.carmel.ca.us/carmel/ on 5/8/2017 in accordance with the applicable legal requirements.

Michael Branson, City Forester

SUPPLEMENTAL MATERIAL RECEIVED AFTER THE POSTING OF THE AGENDA
Any supplemental writings or documents distributed to a majority of the Community Activities and Cultural Commission members regarding any item on this agenda, received after the posting of the agenda will be available for public review in the Public Works Department Office located on the east side of Junipero Avenue between Fourth and Fifth Avenues during normal business hours.

SPECIAL NOTICES TO PUBLIC
In compliance with the Americans with Disabilities Act, if you need special assistance to participate in this meeting, please contact the City Clerk's Office at 831-620-2007 at least 48 hours prior to the meeting to ensure that reasonable arrangements can be made to provide accessibility to the meeting (28CFR 35.102-35.104 ADA Title II).

CHALLENGING DECISIONS OF CITY ENTITIES The time limit within which to commence any lawsuit or legal challenge to any quasi-adjudicative decision made by the City of Carmel-by-the-Sea is governed by Section 1094.6 of the Code of Civil Procedure, unless a shorter limitation period is specified by any other provision, including without limitation Government Code section 65009 applicable to many land use and zoning decisions, Government Code section 66499.37 applicable to the Subdivision Map Act, and Public Resources Code section 21167 applicable to the California Environmental Quality Act (CEQA). Under Section 1094.6, any lawsuit or legal challenge to any quasi-adjudicative decision made by the City must be filed no later than the 90th day following the date on which such decision becomes final. Any lawsuit or legal challenge, which is not filed within that 90-day period, will be barred. Government Code section 65009 and 66499.37, and Public Resources Code section 21167, impose shorter limitations periods and requirements, including timely service in addition to filing. If a person wishes to challenge the above actions in court, they may be limited to raising only those issues they or someone else raised at the meeting described in this notice, or in written correspondence delivered to the City of Carmel-by-the-Sea, at or prior to the meeting. In addition, judicial challenge may be limited or barred where the interested party has not sought and exhausted all available administrative remedies.

The next regular meeting is June 8, 2017
Tour of Inspection – as required
3:30 p.m. – Regular Agenda

CITY OF CARMEL BY-THE-SEA
FOREST AND BEACH COMMISSION-MINUTES
REGULAR MEETING
THURSDAY, APRIL 13, 2017

TOUR OF INSPECTION

Call to order for Tour of inspection:

1. Tour of completed invasive tree removal site and proposed invasive tree removal site adjacent to the Flanders House at 25800 Hatton Road.

CALL TO ORDER AND ROLL CALL

COMMMISSION MEMEBRS PRESENT:	David Refuerzo – Chair Karen Ferlito Mo Massoudi Al Saroyan
COMMISSION MEMBERS ABSENT:	Stephanie Locke – Vice Chair
STAFF PRESENT:	Mike Branson, City Forester Matt Feisthamel, Assistant City Forester Yvette Oblander, Commission Secretary/Admin Coordinator Rob Culver, Public Works Superintendent/ Acting Public Works Director Agnes Topp, Environmental Compliance Manager Don Freeman, City Attorney

ROLL CALL

Chair Refuerzo called the meeting to order at 3:30 PM.

PLEDGE OF ALLIGANCE

Commissioners and members of the audience participated in the Pledge of Alliance.

INTRODUCTION OF PUBLIC WORKS STAFF

Rob Culver – Public Works Superintendent/Acting Public Works Director
Agnes Topp – Environmental Compliance Manager

PUBLIC APPERANCES

No public appearances

ANNOUNCEMENTS

Chair Refuerzo announced that there will be a Carmel Residents Association beach cleanup on Saturday April 15, 2017 from 10:00 to 12:00.

ORDERS OF BUSINESS

1. Discuss and ask questions on the Commission responsibilities under the Brown Act with the City Attorney, Don Freeman.

Mr. Freeman gave an overview on the rules of the Brown Act and also answered questions from the Commissioners and staff.

CONSENT AGENDA

2. Consideration of the minutes for the March 9, 2017 regular meeting.

Commissioner Massoudi moved to approve the minutes, seconded by Commissioner Ferlito. The motion passed by the following vote:

AYES:	Massoudi, Refuerzo, Ferlito, Saroyan
NOES:	
ABSTAIN:	
ABSENT:	Locke

ORDERS OF BUSINESS

3. Report of the 2017 Arbor Day event committee

Mr. Feisthamel spoke on behalf of the ad hoc committee in regards to ideas for Arbor Day. They would like to come up with a general theme this year, and maybe include a tree giveaway. They also discussed different locations for this year's event. The ad hoc committee would also like to work alongside the Friends of Carmel Forest for the event. Commissioner Massoudi added that they would like to make this an educational experience for everyone involved, as well as bring the community together for a special Arbor Day.

4. Report on the City of Carmel Tree Inventory Data

Mr. Branson gave a brief report on the data from the most recent four-year Carmel tree survey and how it compares to past surveys. One quarter of the City is surveyed each year to collect data on the number and trunk diameters of trees within six tree groups. The data collection has been done by students, staff and volunteers from the Friends of Carmel Forest for over 35 years.

Commissioners were interested in learning more on inventory data collection methods and software options in future years and requested this topic for the next regular meeting.

5. Semi-annual report on the North Dunes Habitat Restoration Project

Joey Canepa gave an overview on the report that she has put together. The report outlines the specific number of new plantings and projects that have been completed, pending projects, as well as goals for the future of the North Dunes Habitat.

6. Receive the City Foresters Report
    a. March tree data

Mr. Branson gave his update on the tree data for the month of March 2017

b. Parks Activities

Friends of Mission Trail had a work party last week, before they were rained out.

c. Beach Activities

One wood burning fire pit has been installed at the beach near Eighth Ave., and no official date has been set as to when the others will be placed. The high tides and surf have delayed additional installations.

d. Tree tagging and replacement report

Data from June 2016 to current has been entered into iWorQ. We are working on updating the information.

e. Other items of interests to the Commission

FUTURE AGENDA ITEMS

Mr. Branson will keep the Commissioners updated on any budget information as it comes available.

ADJOURNMENT

Chair Refuerzo adjourned the meeting at 6:22 PM

CITY OF CARMEL-BY-THE-SEA

Forest and Beach Commission
Staff Report

May 11, 2017
Orders

TO:	Forest and Beach Commissioners
FROM:	Mike Branson, City Forester
SUBJECT:	Report on Tree Inventory options

RECOMMENDATION

Receive and discuss the report.

BACKGROUND / SUMMARY

The City of Carmel has performed an annual tree survey since the mid 1970's to collect data on the number and size of the trees that comprise the urban forest. Over the years the data collection has been done by college students working for the City, regular city staff, and most recently by volunteers from the Friends of Carmel Forest. The annual survey is divided into four segments which covers the majority of the city limits over a four year period with the most recent four year period concluding in 2016.

The City's inventory technology is still rooted in the 1980's. There are many new tree inventory and management software options in use around the country today. Some are used for large scale, wide spectrum forest assessments, while others are scaled to a street level assessment. Before deciding on a particular application, the end result of how the data will be used, as well as cost, should be the primary determining factors in making a choice.

Staff has provided some articles (Attachments 1 - 4), that outline some of the software programs that are in the marketplace, and provide a primer on some of the challenges in deciding how to determine which application is the most effective for the end user. Staff will also provide a demonstration of a free inventory program we are trying out now.

This agenda item is intended to make the Commissioners aware of some of the options that are available, not to make a choice of which program is best for the City at this time.

FISCAL IMPACT

N/A

PRIOR CITY COUNCIL ACTION

N/A

ATTACHMENTS

1. ISA article on tree monitoring practices and challenges
2. List of tree inventory and management software
3. University of Florida Comparison of Urban Forest Inventory and Management Software.
4. USFS Guide to Assessing Urban Forests

Arboriculture & Urban Forestry 2013. 39(6): 292–299

Identifying Common Practices and Challenges for Local Urban Tree Monitoring Programs Across the United States

Lara A. Roman, E. Gregory McPherson, Bryant C. Scharenbroch, Julia Bartens

Abstract. Urban forest monitoring data are essential to assess the impacts of tree planting campaigns and management programs. Local practitioners have monitoring projects that have not been well documented in the urban forestry literature. To learn more about practitioner-driven monitoring efforts, the authors surveyed 32 local urban forestry organizations across the United States about the goals, challenges, methods, and uses of their monitoring programs, using an e-mailed questionnaire. Non-profit organizations, municipal agencies, state agencies, and utilities participated. One-half of the organizations had six or fewer urban forestry staff. Common goals for monitoring included evaluating the success of tree planting and management, taking a proactive approach towards tree care, and engaging communities. The most commonly recorded data were species, condition rating, mortality status, and diameter at breast height. Challenges included limited staff and funding, difficulties with data management and technology, and field crew training. Programs used monitoring results to inform tree planting and maintenance practices, provide feedback to individuals responsible for tree care, and manage tree risk. Participants emphasized the importance of planning ahead: carefully considering what data to collect, setting clear goals, developing an appropriate database, and planning for funding and staff time. To improve the quality and consistency of monitoring data across cities, researchers can develop standardized protocols and be responsive to practitioner needs and organizational capacities.

Key Words. Citizen Science; Forest Inventory and Analysis; i-Tree; Monitoring; Survey; Tree Mortality; Tree Planting.

The proliferation of urban forest inventory systems in the past few decades has allowed practitioners and researchers to quantify forest structure and function, estimate ecosystem services, and manage tree maintenance issues (Miller 1996; McPherson et al. 1999; Nowak and Crane 2000; Brack 2006; Keller and Konijnendijk 2012). Standardized inventory systems have enabled comparisons of tree density, species composition, and cost–benefit ratios across cities (McPherson and Simpson 2002; McPherson et al. 2005; Nowak et al. 2008). While these inventories have enhanced researchers' understanding of urban forests, they provide a snapshot in time, and can quickly become outdated in a changing, complex urban landscape. Long-term monitoring data are essential to understand change over time in urban forests—including trends in tree mortality, growth, longevity, and health—and to assess the impacts of tree planting campaigns and management programs.

Although urban forest researchers and arborists have long recognized the value of monitoring data and systematically updated inventories (Weinstein 1983; Baker 1993; McPherson 1993; Clark et al. 1997; Dwyer et al. 2002, Rysin et al. 2004), they do not yet have coordinated programs to conduct longitudinal studies. The need for long-term monitoring was raised at a recent conference on urban tree growth and longevity (Leibowitz 2012). There have been several long-term monitoring programs in wildland (i.e., non-urban) forest ecosystems in the United States, including the Forest Inventory and Analysis (FIA) and Forest Health Monitoring programs of the United States Department of Agriculture (USDA) Forest Service and Long-Term Ecological Research (LTER) sites sponsored by the National Science Foundation. Although these monitoring programs focus primarily on non-urban systems, the methods and analytical tools can be adapted to urban systems. This is already happening with FIA urban pilot programs (Cumming et al. 2008). The Forest Service has also collected repeated plot-based data using i-Tree Eco in Baltimore, Maryland and Syracuse, New York, U.S. (Nowak et al. 2004; D.J. Nowak 2013. Additionally, there are two LTER sites in urban environments: Baltimore, Maryland and Phoenix, Arizona, U.S.

While researchers pursue long-term data collection in cities, local urban forest practitioners are also engaged in monitoring. Two examples have been published online (Boyce 2010; Lu et al. 2010), but other local monitoring programs exist that are not well documented in the literature. Local monitoring programs are important because cities and their non-profit partners are directly involved with the planting and management of many trees in U.S. cities. By monitoring the trees they plant and maintain, these local programs can adjust their management practices based on performance that is quantified, not anecdotal. Standardized protocols for urban tree monitoring would underpin comparative analyses for benchmarking performance among programs and across time, and promote data sharing among professionals and researchers (Leibowitz 2012).

To assist in the development of standardized urban forest monitoring protocols, the authors sought to learn more about the goals and operations of practitioner-driven monitoring. A questionnaire was disseminated to urban forestry organizations across the United States, specifically targeting local organizations that already conduct monitoring programs and generate longitudinal data. The survey assessed: 1) common goals and motivations for monitoring; 2) the range of methods employed; 3) common challenges; and 4) uses of monitoring data. Participants were also asked to offer suggestions for other local organizations seeking to collect monitoring data, and for researchers aiming to develop standardized protocols.

METHODS

Study Design and Participant Recruitment

The authors targeted local urban forestry organizations in the United States that have collected urban tree monitoring data; only organizations with longitudinal data on individual trees were relevant to the research. Throughout this paper, the term "monitoring" is used to refer to systematically collected data on the same trees over time, and "inventory" in reference to a one-time snapshot of urban forest characteristics. Organizations with lists of planted trees lacking static inventories, follow-up records, or sporadically updated inventories were not included in this study.

To understand practitioner-driven monitoring efforts, the study authors specifically sought monitoring programs developed and led by local urban forestry organizations, rather than researcher-driven monitoring studies (e.g., Nowak et al. 2004; Cumming et al. 2008). Eligible organizations were identified through researcher and peer recommendations. The authors began with a list of a dozen organizations that were known to have relevant monitoring programs. Next, a snowball or chain referral sampling technique was used, asking for peer recommendations from colleagues and staff at the local organizations already identified. Sixty-seven organizations were identified through this process.

Participants were recruited via e-mail in February–April 2012, followed by a phone call to explain the study purpose and verify whether the organization had relevant urban tree monitoring programs. Seventeen organizations did not have relevant monitoring programs, 16 were unresponsive to recruiting attempts, and 34 agreed to participate in the study. Questionnaires were emailed to staff at each of the 34 recruited organizations, with several reminder e-mails and phone calls as needed. Questionnaire design and recruitment techniques were adapted from Dillman's Tailored Design Method (Dillman 1999). Thirty-two organizations completed the survey—a 94% participation rate of those recruited. Most participants completed the survey via e-mail, but one dictated responses over the phone.

Survey Format

The survey contained organization-level and program-level questions. Some organizations had more than one distinct monitoring program; in these situations, the program-level questions were repeated. For example, a few organizations conducted both a cohort mortality study of recently planted trees and a repeated census of neighborhoods or plots. Surveys were customized to each organization with the name(s) of their program(s). Forty-five distinct monitoring programs were included from the 32 participating organizations. Organization-level questions inquired as to the type of organization, number of paid urban forestry staff, challenges with urban tree monitoring, experiences sharing monitoring methods and results, and recommendations for other local organizations and researchers undertaking monitoring projects. The number of full-time equivalent paid staff was limited to individuals working on urban forestry and urban greening issues. This enabled more meaningful comparison of staff at different organizations (e.g., municipalities reported the number of urban forestry employees in the parks and/or streets division, rather than the total staff across all departments). Program-level questions included motivations for the specific monitoring program(s), processes of developing field methods, types of data collected, and uses of monitoring data.

The survey included both multiple-choice and open-ended questions. Multiple-choice questions were usually presented as "check all that apply," including an option for "other," to account for categories that were not anticipated. Responses were re-coded in the "other" category to fit the original categories whenever possible (i.e., it is determined that the participant's explanation for the "other" response fit a category already listed). In a few cases, several participants gave similar responses for the "other" explanation, and the study authors created new response categories.

Data Analysis

Open-ended questions were qualitatively assessed for common themes, counting the number of times participants mentioned similar ideas (Babbie 2007). Themes were not pre-determined. The open-ended questions were independently analyzed by one of the authors and a research assistant, with later discussion to resolve discrepancies in the interpretations. Differences in interpretation typically related to lumping versus splitting topics. Direct quotations from participants are included to provide a deeper view of their experiences and perspectives. Quotes are presented anonymously, with spelling errors corrected.

Results are presented for both the open-ended and multiple-choice questions as a percent of the total number of organization-level or program-level responses. In a few cases, responses were left blank, and in those situations the authors divided by the total number of actual responses for that particular question. For both multiple-choice and open-ended questions, percentage totals are typically >100%, because respondents were not forced to choose only one option.

RESULTS

Types of Organizations Represented

Participating organizations (n = 32) are mainly non-profits (53%) and municipalities (38%), with a smaller proportion of state governments (9%) and utilities (6%). These organizations are located in 17 states plus Washington, D.C. (see Roman 2013 for a complete list of organizations). Most non-profit organizations are focused on urban forestry and urban greening; two are neighborhood associations. The organizations serve a range of geographic areas: cities/municipalities (72%), counties (31%), regions (25%), neighborhoods (22%), and states (6%). The number of full-time equivalent urban forestry staff of these organizations also varies widely (min = 0, 25th percentile = 3, median = 6, 75th percentile = 22, max = 174).

Goals and Motivations for Monitoring

The most common goals (51%) for urban tree monitoring programs were to track tree survival, health, and/or growth, and measure program success. 'Success' itself was generally not clearly defined by respondents, but tree survival and health were implied. Some programs also aimed to evaluate factors related to survival, such as species, planting stock, and maintenance. One participant explained the program goals as follows:

[Our organization] had an assumed survival rate when I started, but nothing to back it up. I wanted to have a legit number that we can claim as the success of our planting and care work.

Another common motivation was conducting monitoring as a proactive approach toward tree care, maintenance, and management (44%). Monitoring data collection was sometimes done at the same time as, or in preparation for, tree maintenance work. Twenty-one percent of program—mostly at non-profit organizations—conducted tree monitoring to educate and engage volunteers, residents, and communities.

Tree monitoring programs were sometimes required by grants or contract obligations; 16% of programs mentioned this as part of their motivation for conducting monitoring. Of all programs, 51% had external funding, and of those with funding, monitoring was required for 48%.

Monitoring Methods

Programs developed their field methods for urban forest monitoring using a mix of in-house program staff (46%) and external assistance (17%). Participants worked with paid consultants, university or USDA Forest Service researchers, and other local urban forestry organizations. Some programs (12%) adapted their monitoring methods from the i-Tree inventory software (www.itreetools.org), which was developed by the Forest Service. Field work was carried out mostly by program staff (62%), followed by volunteers (42%), arborists (36%), researchers (16%), interns (16%), and contractors (4%). Thirty-three percent of programs developed a field manual for their monitoring project.

The most commonly recorded tree characteristics for urban tree monitoring programs were species (96%), condition rating (89%), mortality status (76%), diameter at breast height (DBH; 71%), and specific health problems (67%). Many other tree size metrics, maintenance issues, and site characteristics were recorded (Table 1). Half (53%) of the programs exclusively monitor trees planted by their organization, while others monitor only trees not planted by their organization (9%) or both (38%). Street trees were the most common (86%) type of tree location included in these programs, followed by public park trees (45%), institutional trees (34%), residential yard trees (25%), conservation areas (7%), and other (14%). The most common way to record tree location was street address (78%), with many other techniques employed (Table 2); tree location was often recorded in several ways.

The sampling designs for these monitoring programs also varied widely. Seventy-three percent used a complete survey of all trees in a particular program or neighborhood, 16% used a stratified random sample, 9% used a simple random sample, 7% used a convenience sample (i.e., trees or plots selected based on convenience for program personnel), 7% used a targeted sample (i.e., trees chosen based on program interests, such as limiting to a few species), and 4% used another sampling technique. In terms of observation intervals, 64% of programs used a fixed time interval, 43% used a one-time monitoring of recently planted trees, 18% used a rolling schedule (e.g., visit 20% of all trees every year, to reach all trees in five years), and 30% used another observation interval. Some of these monitoring programs were very recently implemented (43% of programs had been instituted within 1–5 years of the survey), while other programs were well established within the organization (26% for 6–10 years, 14% for 11–20 years, and 17% for >20 years).

Monitoring data were managed using a wide assortment of software, including Excel (49%), Access (44%), GIS (22%), i-Tree (18%), Lucity (7%), TreeKeeper (4%), and other (20%). Thirty-seven percent of programs have a paid staffer dedicated to the management of tree monitoring databases.

Table 1. Field data included by practitioner-based urban tree monitoring programs (n = 45).

Data collected	Percent of total
Tree characteristics	
Species	96%
Health condition rating	89%
Mortality status	76%
Diameter at breast height	71%
Specific health problems	67%
Height	38%
Canopy width	31%
Canopy dieback	27%
Maintenance issues	
Pruning	56%
Watering	47%
Mulching	47%
Infrastructure conflicts	42%
Staking	36%
Other tree care issues	9%
Site characteristics	
Location type	47%
Land use	36%
Ground cover	27%
Soil characteristics	13%
Canopy cover	4%
Other site characteristics	13%
Other	13%

Table 2. Methods of recording tree location in monitoring programs (n = 45).

Method	Percent of total
Street address	78%
GPS	42%
Site maps	31%
Tree tags	16%
Google maps	13%
Reference point	11%
Map cell number	4%
Other	18%

Challenges with Monitoring

Resource limitation (63%) was the most common challenge to urban tree monitoring at these organizations. Specifically, 50% mentioned lack of staff time and 25% mentioned lack of dedicated funding. Data management and technology challenges were also common (47%), such as time-intensive data entry and management, identifying appropriate software for long-term tree records, and adapting other technologies for tree monitoring. Twenty-eight percent of organizations had challenges developing protocols, including deciding what data to collect, subjectivity of tree condition ratings, and instituting quality assurance and quality control. Twenty-five percent had difficulties with field crew recruitment and/or training, especially for volunteers and student interns. Twenty-five percent had problems implementing the field work, such as reliably locating tree and plots and getting access to private properties. One participant summarized many of the common challenges as follows:

Not knowing what to monitor, no one to monitor, not knowing what questions to ask of the monitoring.

Organizations had many solutions to these challenges. Twenty-five percent improved the process of recruiting and training field crews, particularly non-profit organizations relying on volunteers and student interns. For example, some organizations decided to hire only college-level interns, while others added more training days. Twenty-five percent had solutions to address funding problems. These tactics included incorporating monitoring and staff time into organizational budgets, seeking external grants, and using volunteers. Thirteen percent prioritized data collection to meet immediate management needs, such as tree risk issues for municipal agencies. Other solutions were staff and volunteer dedication (9%) and advice from external consultants or peers (9%). Twenty-two percent of organizations noted that challenges remain and have not been solved.

Uses of Local Monitoring Data

Participants were asked whether monitoring programs influence management at their organizations; 78% said yes. Of these, 60% said that monitoring informs tree planting techniques and maintenance practices. Forty-three percent said that monitoring affects tree species selection, helping to maximize diversity and selection of appropriate species. Twenty-three percent used monitoring to provide feedback to individuals responsible for tree care, such as residents, volunteers, contractors, and municipalities. Twenty percent used monitoring data for tree risk management, often connected to liability and disease concerns; this issue was most commonly mentioned by municipalities.

Data analysis at these programs involved summary statistics (81%), overall survival and/or growth rates (69%), comparisons of survival and growth across groups (50%), spatial analysis (31%), statistical analysis such as χ^2 and ANOVA (19%), and other techniques (17%). Data analysis was carried out by program staff (83%), interns (8%), researchers (8%), volunteers (8%), and consultants (3%). Sixty percent of programs produced written reports on their monitoring projects; two of these were published (Boyce 2010; Lu et al. 2010).

Sharing Monitoring Methods and Results

Participants were asked whether their organizations shared information about their tree monitoring program(s) with other urban forestry organizations; 56% said yes. Information was shared through a variety of mechanisms. Fifty-six percent of those who share information did so through direct communication with colleagues at other organizations, 33% shared through state or regional networks, and 22% shared at conferences.

Participants described the value in sharing monitoring methods and results across cities. Fifty-five percent valued the opportunity to learn from the best practices and methods in other cities and programs. Twenty-one percent commented that sharing methods and approaches can lead to greater efficiency:

It increases efficiency—you don't have to "re-create the wheel" for each tree planting/monitoring program. We can learn from other's experience.

Organizations also valued the ability to share findings across cities and programs (21%), with some specifically noting the value of standardized methods for meaningful comparison of data (17%).

Suggestions for Other Practitioners and Researchers

Participants were asked to offer guidance to another local urban forestry organization seeking to develop a tree monitoring program. Most recommendations addressed the importance of advance planning. Fifty-two percent of respondents emphasized the importance of thinking carefully about methods and data collection. Forty-two percent said that monitoring programs should have clear goals and intended uses of the data. Forty-two percent mentioned the importance of a good database, especially of the initial inventory or planting records. Twenty-nine percent suggested planning ahead for budgeting, funding, staffing needs, and field crew time. One participant captured many of these common recommendations as follows:

They need to know what the purpose is for the information. If you're taking the time to do it, what's the point? This helps drive what data you collect. Know who is going to do the work, and make sure they have the time and experience to do it properly.

Participants were also asked how researchers can be useful to enhance their urban forest monitoring program(s). Forty-four percent asked researchers to provide best practices and methods for monitoring, including standardized protocols. For example, one participant noted that small organizations have limited capacity, and would appreciate input from researchers on best practices for tree monitoring.

Twenty-two percent of organizations suggested that researchers should develop tools for monitoring, such as technology and software solutions. Nineteen percent requested that researchers continue to produce information on tree benefits and ecosystem services, which help justify funding for urban forest programs. Fifteen percent would like researchers to provide accurate estimates of tree mortality, growth, and canopy change. Eleven percent noted that university and/or government researchers have already been useful.

Finally, the study authors asked for recommendations with the development of standardized urban tree monitoring protocols. Thirty-one percent suggested that protocols should be adaptable to different organizational capacities and needs, and be flexible for different situations. Another suggestion (21%) was to be inclusive and involve practitioners in the protocol development process. Some participants (21%) stressed the importance of keeping protocols simple for users, rather than "complicated and academic."

DISCUSSION

Common goals and motivations for practitioner-driven urban forest monitoring emerged from the analysis. These goals were often echoed in later responses about field methods and uses of the data. For example, programs that evaluated trees planted by their organization used the results to inform planting practices, and municipalities that managed mature urban trees tracked potential hazard trees, and used the results to prioritize maintenance. However, not all programs had clear linkages between monitoring goals, field methods, and uses of the data. At the same time, when asked to offer guidance for other organizations embarking on tree monitoring programs, participants' most common recommendations were to carefully consider what data to collect and have clearly articulated goals.

Research ecologists have similarly stressed the importance of clear questions and objectives in long-term monitoring (Lindenmayer and Likens 2010). Monitoring is not a goal in and of itself, but rather, a means to answering questions (Lovett et al. 2007; Lindenmayer and Likens 2010). Other attributes of effective ecological monitoring are dedicated leadership and institutional commitment; strong partnerships among scientists, resource managers, and policy-makers; careful selection of core variables to measure; frequent use of the collected data; plans for long-term data accessibility; and an adaptive monitoring framework that responds to new technologies and research questions (Lovett et al. 2007; Lindenmayer and Likens 2009; Lindenmayer and Likens 2010). Monitoring projects that lack strong research questions and plans for data analysis may become "snowed by a blizzard of ecological details" from a poorly focused "laundry list" of measurements (Lindenmayer and Likens 2010). The "data-rich but information-poor" scenario in environmental monitoring programs (Ward et al. 1986) has led to monitoring programs being criticized as unscientific (Lovett et al. 2007; Lindenmayer and Likens 2009). While these comments are focused on monitoring for academic and research purposes, long-term ecological datasets often address basic research goals while generating useful data for environmental managers and policymakers (Magurran et al. 2010; Lindenmayer and Likens 2010). The same guidelines for effective monitoring apply to urban forests, because long-term monitoring can produce data for both researchers and practitioners.

Survey participants encountered challenges with urban forest monitoring that were previously raised by Baker (1993): consistency in field crew training, accurately recording tree location, and managing data. Often, existing inventory software did not meet participants' needs for long-term data collection and longitudinal data storage. Researchers can significantly improve the quality and consistency of monitoring data across cities by developing standardized protocols, offering technology solutions, and being responsive to practitioner needs and organizational capacities. Standardized monitoring protocols can extend from existing urban forest data standards and inventory methods (Miller 1996; McPherson et al. 1999; Nowak and Crane 2000; Brack 2006; Keller and Konijnendijk 2012), with special attention to issues that are unique to long-term data collection, such as managing longitudinal datasets and accurately recording tree location and DBH growth. Technology solutions for monitoring could include mobile interfaces for data collection and remote sensing to reduce the need for costly ground-based approaches. In offering suggestions for standardized protocols, survey respondents urged researchers to "keep it simple," rather than "complicated and academic," to enable more organizations to participate. Researchers must remain cognizant of the fact that many local organizations engaged in monitoring have a small number of urban forestry staff (one-half with six or fewer), and that most local organizations do not have staff dedicated to database management. Developing, implementing, and analyzing long-term monitoring projects are significant challenges for organizations with few staff and limited resources. By providing standards for long-term data collection and analysis, researchers can enhance the institutional capacity of these organizations to generate rigorous data that addresses their management needs. Standardization would also promote the sharing of information among practitioners. While survey participants recognized many values in sharing monitoring approaches and results, few consulted with external colleagues in developing their methods, and only about half currently share their results and methods with other organizations.

Linking planting grants to monitoring and maintenance funds would be one step forward in addressing the hurdle of resource limitations faced by many local monitoring programs. One-quarter of the programs surveyed were required to monitor due to grant obligations. Urban forestry initiatives should tout exemplary records of tree survival and health, rather than sheer numbers of trees planted. With increased interest in urban tree monitoring from funders, more local organizations may begin monitoring, or may formalize their existing programs. Additionally, regulatory-based programs, such as California's cap and trade offset program (California Air Resources Board 2011), allow for urban tree planting as a mitigation measure because of projected ecosystem services (McHale et al. 2007; Poudyal et al. 2011), and are including reporting requirements for tree survival and growth. Reliable funding sources have also been a concern in long-term environmental and ecological monitoring (Caughlan and Oakley 2001; Lovett et al. 2007), and dedicated funding from national agencies has been important for long-term ecological research in the United States (e.g., LTER and FIA). Finding consistent funding for long-term urban tree monitoring is likely to require new partnerships among federal and state agencies, industries, and non-profits.

Reliance on volunteers for field data collection was one strategy employed by participants to keep costs down, particularly among non-profit organizations. Volunteer-based data collection and citizen science in urban forestry can promote environmental awareness and create a more informed constituency (Bloniarz and Ryan 1996; Cooper et al. 2007; Abd-Elrahman et al. 2010). Citizen science is also employed in long-term ecological monitoring in other systems (Silvertown 2009; Dickinson et al. 2010; Magurran et al. 2010; Dickinson et al. 2012), such as the Audubon Society's Christmas Bird Count. While data collected by volunteers has the potential for error and bias, the extent of this error is poorly understood (Dickinson et al. 2010). Errors can be minimized with data validation procedures whereby scientists follow up on data entries flagged as potential problems (Bonter and Cooper 2012; Gardiner et al. 2012). Bloniarz and Ryan (1996) found that with adequate training, volunteer-based urban tree inventories can produce mostly accurate data at lower cost than professional arborists. The survey participants also noted that effective volunteer and intern training is essential to producing high-quality data.

Collaboration between researchers and practitioners will be essential to develop effective monitoring standards and implement long-term data collection. Dialogue between researchers, managers, and arborists has been central to urban forestry for many decades, recognizing the strengths that each party brings to collaborations, as well as the difficulties in two-way communication (Shigo 1976; Dwyer 1987). Survey participants requested that researchers have an inclusive process to develop standards, and create flexible protocols adaptable to different organizations' needs. Collaborative, community-based, and participatory approaches are increasingly common in other disciplines, such as city planning (Forester 1999; Rotmans and Van Asselt 2000), natural resource management (Fortmann 2008; Wilmsen 2008), and public health (O'Fallon and Dearry 2002; Minkler and Wallerstein 2008). Following from the principles of community-based participatory research (O'Fallon and Dearry 2002), local urban forestry organizations should be involved in setting goals, developing methods, collecting data, and disseminating results. For example, Wolf and Kruger (2010) used structured discussions among urban forest managers, professionals, and researchers in the U.S. Pacific Northwest to identify and prioritize research topics. Urban forestry practitioners can contribute their professional expertise and insights into local conditions, thereby enhancing the quality of the research. Continued dialogue between researchers and practitioners will be necessary to ensure that future urban forest monitoring projects are both scientifically rigorous and useful for local management concerns.

CONCLUSION

To the best knowledge of the study authors, this is the first comprehensive survey of local urban tree monitoring programs in the United States. As such, the study provides information to establish a baseline for current practices in urban forest monitoring. It was found that monitoring programs are chiefly implemented by non-profits and municipal agencies to measure program success, inform on management practices, and provide educational experiences for volunteers and communities. Insufficient staff time and funds for monitoring are primary limitations. Representatives from monitoring programs expressed eagerness to share monitoring strategies and lessons learned. Participants stressed that decisions about what data to collect should closely align with monitoring goals. The development and adoption of standardized monitoring protocols would assist these organizations by diverting scarce resources from protocol development to crew training and field data collection.

The results and conclusions may be biased due to the limited sample size; there may be other urban tree monitoring programs in the United States that were unintentionally omitted. Nevertheless, by including 32 organizations with a range of characteristics and monitoring methods, sufficient information was gathered to assess the goals, challenges, methods, and uses of practitioner-driven monitoring. The observations gleaned from this survey can inform the next generation of urban tree monitoring, with researchers and practitioners collaborating for long-term data collection.

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Zussamenfassung. Die Daten aus der Überwachung urbaner Forste sind notwendig für die Bewertung des Einflusses von Baumpflanzaktionen und Pflegeprogrammen. Lokale Anwender haben Überwachungsprojekte, welche bislang in der Literatur zur Urbanen Forstwirtschaft nicht gut dokumentiert wurden. Um mehr über die Anwender-gesteuerten Überwachungsprojekte zu lernen, befragten die Forscher 32 lokale urbane Forstorganisationen in den USA über Zielsetzungen, Herausforderungen, Methoden und Gebrauch ihrer Überwachungsprogramme, indem sie per email einen Fragebogen verschickten. Nicht gewinnorientierte Organisationen, kommunale Dienststellen, staatliche Dienststellen und Versorgungsunternehmen nahmen daran teil. Eine Hälfte der Organisationen hatte sechs oder weniger Mitarbeiter. Allgemeine Ziele der Überwachung schlossen eine Bewertung des Erfolgs von Pflanzungen und Pflege ein, wobei eine Initiative zur Baumpflege ergriffen wurde und zur Einbeziehung der Kommunen. Die meisten allgemein aufgezeichneten Daten betrafen Baumarten, Zustandsbewertungen, Sterberaten und Durchmesser in Brusthöhe. Die Herausforderung bestanden in begrenzten Mitarbeitern und Mitteln, Schwierigkeiten mit der Datenverwaltung und Technologie, sowie praxisorientierte Mitarbeiterschulung. Die Programme nutzten die Überwachungsergebnisse, um Baumpflanzungen und Pflegemaßnahmen anzuweisen, liefern Feedback an verantwortliche Personen in der Pflege und verwalten Baumrisiken. Die Anwender hoben die Bedeutung der vorausgehenden Planung hervor: eine sorgfältige Abwägung, welche Daten zu sammeln sind, klare ziele zu setzen, eine anwenderfreundliche Datensammlung zu entwickeln, sowie eine Planung für benötigte Mittel der Umsetzung einschließlich Mitarbeiterzeit. Um die Qualität und Konsistenz der erhobenen Daten in den Städten zu verbessern, können die Forscher standardisierte Protokolle entwickeln und auf die Bedürfnisse der Anwender und organisatorischen Kapazitäten eingehen.

Resumen. Los datos del monitoreo de los bosques urbanos son esenciales para evaluar el impacto de las campañas de plantación de árboles y programas de gestión. Los practicantes locales han dado seguimiento de los proyectos que no han sido bien documentados en la literatura forestal urbana. Para obtener más información sobre los esfuerzos de monitoreo, los investigadores encuestaron a 32 organizaciones forestales urbanas locales en los Estados Unidos acerca de las metas, retos, métodos y usos de los programas de control, mediante un cuestionario enviado por correo electrónico. Participaron las organizaciones no lucrativas, agencias municipales, agencias estatales y servicios públicos. La mitad de las organizaciones tenía seis o menos personal de dasonomía urbana. Los objetivos comunes para el monitoreo incluyeron la evaluación del éxito de la plantación y manejo de árboles, tomando un enfoque proactivo hacia el cuidado de los árboles con la participación de las comunidades. Los datos registrados más comunes fueron las especies, calificación de condición, el estado de la mortalidad y el diámetro a la altura del pecho. Los desafíos incluyen limitaciones de personal y la financiación, las dificultades con la gestión y la tecnología de información y formación del equipo de campo. Los programas utilizan los resultados del monitoreo para informar de la plantación de árboles y las prácticas de mantenimiento, proporcionar información a las personas responsables del cuidado del árbol y gestionar el riesgo del árbol. Los participantes hicieron hincapié en la importancia de planificar: considerando cuidadosamente los datos a colectar, estableciendo objetivos claros, desarrollando bases de datos adecuadas y planeando los fondos y el tiempo del personal. Para mejorar la calidad y la consistencia del monitoreo de datos a través de las ciudades, los investigadores pueden desarrollar protocolos estandarizados y ser sensibles a las necesidades y capacidades organizativas de los practicantes.

13

Tree Inventory and Management Software

Revised January 2014

Commercial Inventory Software

Commercial software programs listed here were identified through web searches. Any omissions from this list are unintentional. Please contact Jill Johnson at jilljohnson@fs.fed.us to be added to the list.

Many urban forestry consultants have developed their own programs that are available as part of an inventory service contract but not independently. If you will be contracting for inventory data collection, check with potential consultants to learn about their software.

ArborAccess®
http://westcoastarborists.com/services/management-services/tree-management-software/

ArborPro®
http://www.arborprousa.com

ArborSoftWorx®
http://www.arborsoftworx.com/ArborSoftWorx-Green-Asset-Manager-Overview.html

StrataPoint®
http://www.stratapointinc.com/solutions/cities

Tree Management & Maintenance Solutions
http://govmanage.com/trees.html

TreeKeeper®
http://www.davey.com/services/urban-forestry/urban-forestry-management-software/

Tree Plotter©
www.planitgeo.com

TreeSites®
http://www.fothtreesites.com/

TreeTracker®
http://www.treetrackersoftware.com/

TreeWorks®
http://www.kenersongroup.com/treeworks.aspx

TRIMS Tree Inventory
http://www.trims.com/trees.htm

UFIS
http://www.nrtech.com/f_ufis..htm

Freeware or Public Domain Software

Community and Urban Forest Inventory and Management Program (CUFIM)
http://www.ufei.org/websites.lasso

i-Tree Software Suite
www.itreetools.org

OpenTreeMap
http://www.azavea.com/opentreemap/

PlantMapper
http://www.plantmapper.com/

Talking2Trees
http://talking2trees.com/

Tree Plotter LITE
www.planitgeo.com

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Comparison of Urban Forest Inventory & Management Software Systems[1]

Michael G. Andreu, Erin M. Brown, Melissa H. Friedman, Robert J. Northrop, and Mary E. Thornhill[2]

Background

In 1997, Olig and Miller published *A Guide to Street Tree Inventory Software*, providing a comparison of software providers, customization options, and data-entry time estimates for each software. After twelve years much of the information is outdated due to the rapid development of new technology and software upgrades. In 2006, the University of Florida held an Urban Forest Inventory Systems Symposium. This meeting brought together a suite of urban forest professionals to share their considerations when selecting tree inventory software systems and how these systems facilitated their management efforts (Andreu et al 2007). During this symposium it became apparent that an updated resource for selecting a tree inventory software system was needed. Coincidentally, in 2007, the US Forest Service published *Tree Inventory and Management Software* (USFS 2007), which provided a brief one-paragraph description of each of the software systems available at the time.

Introduction

This extension publication examines many of the tree inventory software systems available as of 2009. It provides up-to-date information about previously existing tree inventory software systems as well as those recently launched. However, the list of software systems provided here is not comprehensive, as we only included companies that we were able to successfully interview. The information provided in this publication has been reviewed and approved by each inventory system software provider. As a result, this synthesis pulls together more details of tree inventory software systems than previously available in one document.

> Ideally the software system will *support* and not *dictate* a user's management objectives and activities.

When selecting a tree inventory software system, it is important to assess the user's needs and objectives so that the proper system can be chosen. Ideally the software system will *support* and not *dictate* a user's management objectives and activities. Below are some factors to consider when selecting a tree inventory software system:

1. This document is FOR226, one of a series of the School of Forest Resources and Conservation Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. First published: August 2009. Visit the EDIS Web site at http://edis.ifas.ufl.edu.
2. Michael G. Andreu, assistant professor; Erin M. Brown, research assistant; Melissa H. Friedman, biological scientist; Robert J. Northrop, extension forester; and Mary E. Thornhill, graduate student; School of Forest Resources and Conservation; Institute of Food and Agricultural Sciences; University of Florida; Gainesville 32611.

- What types of questions is the inventory going to answer?
- Who is responsible for managing the urban forest inventory system?
- Are the software and data export files compatible with other software systems that are commonly used?
- How much training time is required and how much does it cost?
- What kind of upgrades and technical support does the software company offer?

For the purposes of comparing the features and capabilities of various tree inventory software systems, we have provided information in four tables. These tables are designed to allow managers to quickly assess which software systems offer the features they desire. Brief summaries, or 'mini spec sheets,' for each inventory system follow to provide additional information, such as typical clients/user types, upcoming upgrades, software costs, technical support, and contact information.

Guide to Tree Inventory Software Comparison Tables

Table 1 provides a comparison of the features and capabilities of each software system. The ***Customizable Data Fields*** and ***Customizable Reports*** features indicate which system allows users to tailor the software system design and data format to meet their data collection or analysis needs. The ***Work Order Generation*** and ***Track Maintenance*** features allow managers to document and manage tree maintenance and field crew schedules. Some systems include a geographic information system or ***GIS Component***, which allows users to view their tree data and create maps. The ***Tree Valuation*** field indicates which systems have a tree valuation component. The ***Photographs, Sketches or Diagrams*** field indicates the ability to attach image files to a tree record in the inventory. The ***Inventory Other Assets*** field indicates which systems can manage other assets beyond trees (e.g. street signs, park benches, utilities). The ***Sync with Field Devices*** field indicates which systems allow users to synchronize their field data collection devices (e.g. personal digital assistant) with their personal computers for data transfer. The ***Web-based Software*** field indicates which software operates via the Internet. And lastly, the ***Network Installation*** field simply indicates that the software can be installed on a network for multiple users.

Table 2 provides a comparison of the various self explanatory data fields that can be customized: ***species list, maintenance recommendations, work areas/neighborhoods,*** and ***appearance.***

Table 3 designates the types of Geographic Information Systems (GIS) components that are utilized by each software system: ***ESRI-Compatible, ESRI GIS System, Non-ESRI Mapping or GIS System***. Additionally, it provides information about which software systems allow tree attribute data to be modified (***Modify Tree Data in GIS Mode***), and which systems allow users to alter the spatial coordinates of trees while in the GIS mode (***Manually Edit Trees in GIS Mode***).

Table 4 illustrates the operating system requirements for each software system: ***Windows 98, Windows 2000, Windows XP, Windows Vista, Mac OS X,*** and ***Linux***. The ***Internet-based*** column indicates which software systems are only accessible via Web browser. This means that the software system cannot be installed on a local hard drive or intranet, and therefore requires an Internet connection.

Table 1. Comparison of software capabilities and features.

Software & Features	Customizable Data Fields [1]	Work Order Generation	Track Maintenance	Customizable Reports	GIS Component [2]	Tree Valuation	Inventory other Assets	Photographs, Sketches or Diagrams	Sync with Field Devices	Web-based Software	Network Installation	COSTS
ArborAccess	•	•	•	•	•	•	•	•		•		See Spec Sheet
ArborPro	•	•	•	•	•	•	•	•	•		•	$5,000 + †
ArborSoftWorx *C**		•	•	•	•	•	•	•	•		•	$1,000 +†
ArborSoftWorx *M***		•	•	•	•	•	•	•	•		•	$1,500 +†
ArborVue	•	•	•	•	•	•		•	•		•	$2,995 +†
Asset Manager	•	•	•	•	•		•	•	•			$3,300
i-Tree (*Streets*)	•		•			•	•					Free
i-Tree (*Eco*)					•	•						Free
PDM-O***	•	•	•		•	•	•	•	•	•		$1,000-3,000/year
Silvibase 5.1	•	•	•	•		•		•	•			$2,000-3,000
Tree Keeper 7.6	•	•	•	•	•	•	•	•	•	•	•	See Spec Sheet
Trees in the Hood	•	•	•	•	•	•	•	•	•		•	Free +†
TreeWorks	•	•	•	•	•	•	•		•		•	See Spec Sheet
Trims	•	•	•	•					•		•	$1,495 +†
UFIS ****	•	•	•	•	•	•	•		•			$6,000

* ArborSoftWorx *Commercial*
** ArborSoftWorx *Municipal*
*** Point DataMap-Online
**** Urban Forest Inventory Systems
[1] See Table 2 for a further comparison of customizable data fields.
[2] See Table 3 for further comparisons of GIS features.
†The + indicates that there is an annual support package or maintenance fee in addition to the base price.

Table 2. Comparison of data field customization.

Customizable Data Fields	ArborAccess	ArborPro	ArborVue	AssetManager	i-Tree (*Street*)	PDM-O *	Silvibase 5.1	TreeKeeper 7.6	Trees in the Hood	TreeWorks	Trims	UFIS **
Species List		•	•	•	•	•	•	•	•	•	•	•
Maintenance Recommendations	•	•	•	•	•	•	•	•	•	•	•	•
Work Areas/Neighborhoods	•	•	•	•	•	•	•	•	•	•	•	•
Appearance (skins)	•	•	•	•		•			•	•		•

* Point DataMap-Online

** Urban Forest Inventory Systems

Table 3. Comparison of GIS components.

GIS Components	ArborAccess	ArborPro	ArborSoftWorx *C* *	ArborSoftWorx *M* **	ArborVue	AssetManager	i-Tree (*Eco*)	PDM-O ***	TreeKeeper 7.6	Trees in the Hood	TreeWorks	UFIS ****
ESRI Compatible	•	•	•	•	•	•		•	•	•	•	•
ESRI GIS System					•	•			•		•	
Non-ESRI Mapping or GIS System	•	•	•	•			•	•				•
Modify Tree Data in GIS Mode		•			•	•		•	•	•	•	•
Manually Edit Trees in GIS Mode		•			•	•		•	•	•	•	•

* ArborSoftWorx *Commercial*

** ArborSoftWorx *Municipal*

*** Point DataMap-Online

**** Urban Forest Inventory Systems

Table 4. Comparison of Operating Systems (OS) Compatibility.

Software OS Requirements	**Windows 98**	**Windows 2000**	**Windows XP**	**Windows Vista**	**Mac OS X**	**Linux**	**Internet-based**
ArborAccess							•
ArborPro	•	•	•	•			
ArborSoftWorx *C**	•	•	•	•		•	
ArborSoftWorx *M***	•	•	•	•		•	
ArborVue			•	•			
Asset Manager	•	•	•	•			
i-Tree (*Street*)		•	•				
i-Tree (*Eco*)		•	•				
PDM-O* **							•
Silvibase 5.1		•	•				
Tree Keeper 7.6							•
Trees in the Hood	•	•	•	•	•		
TreeWorks		•	•	•			
Trims		•	•	•			
UFIS *****	•	•	•				

*** ArborSoftWorx *Commercial***
**** ArborSoftWorx *Municipal***
***** Point DataMap-Online**
****** Urban Forest Inventory Systems**

The following pages include
Individual Tree Inventory Software Spec Sheets
For detailed technical specifications, visit vendor Web sites.

ArborAccess©

Introduction to Software

ArborAccess Online is an internet-driven software developed by tree care professionals at West Coast Arborists, Inc. (WCA). It is accessible only to WCA clients, who are primarily municipalities in California. ArborAccess can be customized to the needs of each WCA client. According to West Coast Arborists, it can store an unlimited number of tree records.

Services

- Tree Inventories
- Tracks Maintenance History
- GIS Mapping
- Budget Projections
- Basic Tree Appraisals

Additional Information

An upgraded version of ArborAccess is projected to be available by 2009. This version will be an ArcIMS compatible system. It will allow users to interact with and modify the inventory data through the database and/or the GIS maps via the Internet.

Operating System Requirements

Internet Connection and Web browser (*e.g.* Internet Explorer 5.5 or greater)—ArborAccess does not require additional hardware, memory, or software; as it is stored on WCA's server and functions remotely.

Software Costs

The cost of ArborAccess is included in municipal contracts. Contact WCA for further details.

Technical Support

WCA offers unlimited training and support to their clients. Periodic workshops are offered for larger groups or after software upgrades have occurred. WCA's Area Managers are also available to assist clients on an as-needed basis.

Contact Information

West Coast Arborists, Inc.
2200 East Via Burton Street
Anaheim, CA 92806
Phone: 1-800-521-3714
Fax: 1-714-956-3745
Email: info@wcainc.com
Web site: http://www.wcainc.com

ArborPro

Introduction to Software

ArborPro was developed and is distributed by ArborPro Management Software. ArborPro is a tree management software designed to manage trees, the landscape, and physical assets. It is used by municipalities, parks, campuses, and golf courses. ArborPro has been tested and is able to store over a million tree records.

Services

- Tree Inventories
- Tracks Maintenance History
- GIS Mapping
- Tree Hazard Assessments
- Crew Management Program
- Budgeting

Additional Information

ArborPro has a new measuring tool that allows clients to see the distance between two assets on the map. For example, planting distance between trees, distance from trees to park assets or buildings, and tree canopy spreads can be measured.

Operating System Requirements

Windows 98, Windows 2000, Windows XP, or Windows Vista

Software Costs

The base price for ArborPro is $5,000.

Technical Support

After the initial purchase of ArborPro, 2 eight-hour training sessions are available free of charge: (1) initial training session, (2) focused training session. ArborPro also offers an optional annual support package (includes upgrades) for $1,500.

Contact Information

ArborPro, Inc.
P.O. Box 4096
Newport Beach, CA 92661-4096
Phone: 1-877-844-DATA (3282)
Fax: 1-714-694-1981
Email: info@arborprousa.com
Web site: http://www.arborprousa.com

ArborSoftWorx® *Commercial*

Introduction to Software

ArborSoftWorx was developed and is distributed by Creative Automation Solutions, Inc. ArborSoftWorx *Commercial* is primarily a customer and business management software. It is designed for arbor, landscape, and plant health care companies.

Services

- Customer Relationship Management
- Business Management (accounting, invoicing, and receivables)
- Scheduling, Routing, and Mapping of Field Crews
- Chemical Tracking and Reporting
- Property Inventory
- Company Asset Management
- Personnel Management

Additional Information

ArborSoftWorx can support single office operations and/or multiple branch offices. Data and reports can be exported into all Microsoft, Corel, and Lotus Office suites. Creative Automation Solutions, Inc. also offers data conversions into i-Tree.

Operating System Requirements

Windows 98, Windows 2000, Windows XP, Windows Vista, or Linux

Software Costs

The base price for a single user is $1,000. Additional features are available; the price will vary depending on how many additional features the client requests. Contact a sales associate for network system prices.

Technical Support

On-site installation and training is available. An additional support package that includes upgrades is available to clients but the cost varies depending on the number of computers.

Contact Information

Creative Automation Solutions, Inc.
10500 Old Court Rd.
Woodstock, MD 21163
Phone: 1-800-49-ARBOR (2-7267) or 1-410-461-5858
Fax: 1-410-465-3593
Email: Sales@ArborSoftWorx.com
Web site: http://www.arborsoftworx.com

ArborSoftWorx® *Municipal*

Introduction to Software

ArborSoftWorx was developed by and is distributed by Creative Automation Solutions. ArborSoftWorx *Municipal* is an inventory and asset management software. It is designed for counties, cities, townships, campuses, parks, and estates.

Services

- Tree Inventories
- Track Maintenance History
- Track Service Calls
- Scheduling, Routing, and Mapping of Field Crews
- Tree Risk and Hazard Assessments
- Chemical Tracking and Reporting
- GIS Mapping
- Budgeting

Additional Information

Data and reports can be exported into all Microsoft, Corel, and Lotus Office suites. Creative Automation Solutions, Inc. also offers data conversions into i-Tree.

Operating System Requirements

Windows 98, Windows 2000, Windows XP, Windows Vista, or Linux

Software Costs

The base price for a single user is $1,500. Contact a sales associate for network system prices.

Technical Support

On-site installation and training is available.

Contact Information

Creative Automation Solutions, Inc.
10500 Old Court Rd.
Woodstock, MD 21163
Phone: 1-800-49-ARBOR (2-7267) or 1-410-461-5858
Fax: 1-410-465-3593
Email: Sales@ArborSoftWorx.com
Web site: http://www.arborsoftworx.com

ArborVue

Introduction to Software

ArborVue was developed and is distributed by The Laurus Group. It is a tree inventory management software designed for urban tree managers. According to The Laurus Group, ArborVue can store an unlimited number of tree records.

Services

- Tree Inventories
- Track Maintenance History
- GIS Mapping
- Budgeting
- Tree Damage Evaluations

Additional Information

ESRI's ArcGIS Engine Runtime and/or ArcPad 7 are included in the ArborVue software package. Therefore, ArborVue clients do not have to purchase additional ESRI products to run this software.

ArborVue's database uses SQL Server/SQL Server Express. SQL Server Express is included with the purchase of ArborVue (supports up to 10 concurrent users) but if more users are needed, SQL Server is available. Database hosting is also available for clients who do not wish to maintain SQL Server/SQL Server Express.

Operating System Requirements

Windows 200, Windows XP, or Windows Vista

Software Costs

The base price for ArborVue is $2,995.

Technical Support

The first year of technical supports and upgrades are included in the base price. Afterwards, it is $495/year for additional support and future upgrades. ArborVue offers multiple upgrades each year.

Contact Information

The Laurus Group, LLC.
4912 Bayshore Drive
Seneca, SC 29672
Phone: 1-864-654-8733
Fax: 1-864-654-8889
Email: arborvueinfo@arborvue.com
Web site: http://www.arborvue.com

Asset Manager

Introduction to Software

Asset Manager was developed and is distributed by Davey Resource Group. Asset Manager is a map-based management software designed to help municipalities, golf courses, college campuses, and even amusement parks to manage a variety of assets. Some of these assets include: trees, planting areas, turf areas, greens, fairways, drains, irrigation lines, hydrants, and valves.

Services

- Tree Inventories
- Track Maintenance History
- GIS Mapping
- Budgeting

Additional Information

Asset Manager stores data in ESRI shape files. Data can also be exported to a comma delimited text file, which can then be imported to spreadsheet and database applications.

Operating System Requirements

Windows 98, Windows 2000, Windows XP, or Windows Vista

Software Costs

The base price for Asset Manager is $3,300.

Technical Support

There are two options for technical support: 1) a one day on-site training is available for $1,300, or 2) one year of unlimited support is available for $1,000.

Contact Information

Davey Resource Group
1500 N. Mantua St.
PO Box 5193
Kent, OH 44240-5193
Phone: 1-800-828-8312
Fax: 1-330-673-0860
Email: gis@davey.com
Web site: http://www.davey.com/software

i-Tree

Introduction to Software

i-Tree was developed by the USDA Forest Service, Davey Tree Expert Co., National Arbor Day Foundation, Society of Municipal Arborists, and the International Society of Arboriculture. In the public domain and freely accessible, i-Tree is a software suite that allows managers to analyze and assess the environmental and aesthetic benefits of their urban and community forests. The suite contains two urban forest analysis tools: *Eco* (formerly *UFORE*) for ecosystem level assessments of the entire urban forest; and *Street* (formerly *STRATUM*) for municipal street tree assessments alone.

Services

- Tree Inventories
- Track Maintenance History
- Tree Hazard and Risk Assessments
- Budgeting
- Insect and Disease Assessments
- Environmental and Aesthetic Benefit Assessments
- Ice/Wind Storm Assessments

Additional Information

Street is designed for analyzing street tree populations, not the entire urban forest. *Street* quantifies the annual environmental and aesthetic benefits, as well as the property value increase from street trees. It can be used to compare canopy cover for different neighborhoods, species diversity, tree conflicts and maintenance needs, as well as species performance. New or existing inventories can be formatted for *Street* compatibility.

Eco is designed for analyzing the entire urban forest at the ecosystem level. *Eco* calculates urban forest structure, function, and value using area-based field sampling combined with local air quality and weather information. The urban forest can be examined at any scale and can be stratified (e.g. land-use types).

i-Tree is on a continuous development cycle. In spring of 2009, i-Tree 3.0 was released, enhancing functionality, uniformity, and integration for improved utility.

Operating System Requirements

Windows XP or Windows Vista

Software Costs

i-Tree is a public domain software, distributed at no cost.

Technical Support

i-Tree offers support online, on the phone, or through a user forum. The i-Tree User Forum is a moderated discussion forum that allows users to seek solutions to technical questions, communicate their experiences, and/or view frequently asked questions (FAQs).

Contact Information

i-Tree
1500 N. Mantua St.
Kent, OH 44240
Phone: 1-877-574-8733
Email: info@itreetools.org
Web site: http://www.itreetools.org

PDM-O™ – Point DataMap Online

Introduction to Software

PDM-O was developed and is distributed by StrataPoint, Inc. PDM-O is an internet-driven grounds and tree management software developed for municipalities, golf courses, and campuses. Since it is a web-based technology it can accommodate multiple concurrent users. According to StrataPoint, PDM-O can also store an unlimited number of tree records.

Services

- Tree Inventories
- Track Maintenance History
- GIS Mapping
- Tree Risk Assessment
- Tree Crown/Shade Profiling
- Chemical Tracking
- Irrigation Management

Additional Information

PDM-O facilitates turfgrass management by providing managers with a profile of each tree's crown and its shade profile.

Operating System Requirements

Internet connection and Web browser (Internet-based software)

Software Costs

Clients can subscribe to PDM-O for $1,000–$3,000 per year. Contact a sales associate for more information.

Technical Support
Free online and phone technical support is available to subscribers.

Contact Information
Phone: 1-651-322-4000
Fax: 1-651-322-5747
Email: sales@stratapointinc.com or info@stratapointinc.com
Web site: http://www.stratapointinc.com

Silvibase 5.1

Introduction to Software
Silvibase 5.1 was developed and is distributed by Natural Resource Planning Services, Inc. Silvibase 5.1 operates on a run-time version of Microsoft Access and is intended for small municipalities that do not need additional capabilities, such as GIS.

Services
- Tree Inventories
- Maintenance Plans
- Production Monitoring

Additional Information
Tree data can be directly exported into ArcView. Note: Silvibase 5.1 does not have a built-in mapping component. Additionally, it is not necessary to purchase Microsoft Access, since Silvibase 5.1 operates on a run-time version of Microsoft Access. Silvibase 5.1 also works with Windows CE and ArcPad on portable field devices.

Operating System Requirements
Windows 2000 or Windows XP

Software Costs
The base price for Silvibase 5.1 ranges from $2,000–$3,000, which includes the initial training and set-up.

Technical Support
Available via phone and email, free of charge.

Contact Information
Natural Resource Planning Services, Inc.
5700 SW 34th St. Suite 324
Gainesville, FL 32608
Phone: 1-352-378-8966
Fax: 1-352-336-4877
Email: DaveF@nrpsforesters.com
Web site: http://www.nrpsforesters.com

TreeKeeper® 7.6

Introduction to Software
TreeKeeper 7.6 was developed and is distributed by Davey Resource Group. TreeKeeper 7.6 is an internet-driven tree management software intended for municipalities. It is a web-based technology and can be accessed from home, offices, and anywhere with internet capabilities.

Services
- Tree Inventories
- Tracks Maintenance History
- Tracks Service Calls
- GIS Mapping
- Tree Hazard Assessments and Valuations

Additional Information
Davey Resource Group offers clients an unlimited amount of data field customization, as well as a wide range of report customization. TreeKeeper 7.7 is projected to be released by the time this document has been published. A fully functioning demonstration of TreeKeeper 7.6 is available at *treekeeperonline.com*

Operating System Requirements
Internet connection and Web browser (Internet-based software)

Software Costs (3 options for deployment)
1. *Standalone* – TreeKeeper® 7.6 is installed locally on a PC and can only be accessed on this computer. There is a one time cost of $4,600 for small cities (pop. < 30,000), and $7,700 for larger cities (pop. > 30,000). Note: There is not a concurrent user option with this method and clients are responsible for their data. Upgrades range in cost.
2. *Network* – TreeKeeper® 7.6 is deployed on the client's server, accessed via the internet or intranet. There is a one time cost of $12,000. Note: This option allows for concurrent users and in the long-term (more than 6 years) it is less expensive than the subscription. Clients are responsible for their data and upgrades range in cost.
3. *Subscription* – TreeKeeper® 7.6 is accessed through Davey Resource Group's Web server. In the short-term this is the least expensive option, costing $2100 for a year subscription. There is a 3-year subscription available for $5,250. With the subscription method, data is backed up every night by Davey Resource Group and upgrades are free.

Technical Support

There are two options for technical support: 1) a one-day on-site training is available for $1,300, and 2) one year of unlimited support is available for $1,000.

Contact Information

Davey Resource Group
1500 N. Mantua St.
PO Box 5193
Kent, OH 44240-5193
Phone: 1-800-828-8312
Fax: 1-330-673-0860
Email: gis@davey.com
Web site: http://www.davey.com/software

Trees in the Hood™

Introduction to Software

Trees in the Hood was developed and is distributed by Natural-Path Urban Forestry Consultants. It is a free shareware designed to assist small communities, parks, golf courses, and campuses manage their trees. Trees in the Hood is based in Microsoft Access. According to Natural-Path Urban Forestry Consultants, it can manage an unlimited number of tree records.

Services

- Tree Inventories
- Track Maintenance History
- GIS Mapping
- Production Monitoring
- Tracks Field Crews

Additional Information

The data fields for Trees in the Hood are set up to match *Street* (part of the i-Tree suite). Trees in the Hood offers tree analysis by family, genus, and species. Trunk formula appraisals are based on individual chapter parameters from the Council of Tree and Landscape Appraisers (CTLA).

Operating System Requirements

Windows 98, Windows 2000, Windows XP, Windows Vista, or Mac OS X

Software Costs

The software is free shareware. However, there is a set-up cost that varies depending on the client's needs. Contact the owner, Mark Duntemann, for more information.

Technical Support

Technical support is free for two years; subsequently there is a non-mandatory charge of $250 per year.

Contact Information

Natural Path Urban Forestry
PO Box 1753
Oak Park, IL 60304
Phone: 1-773-699-7284
Email: natpath@earthlink.net
Web site: http://www.naturalpathforestry.com

TreeWorks™

Introduction to Software

TreeWorks was developed and is distributed by The Kenerson Group. TreeWorks is a tree management software developed by a collaboration of GIS specialists and arborists. It is an extension to ArcGIS 9.x Desktop and ArcPad. TreeWorks is commonly used by municipalities, campuses and military bases. It has been shown to store over 500,000 tree records.

Services

- Tree Inventories
- Track Maintenance History
- GIS Mapping
- Tree Risk and Hazard Assessment
- Tree Valuations
- Track Service Calls
- Production Monitoring

Additional Information

TreeWorks is an extension (toolbar) that operates inside of ArcGIS, therefore clients can use all of the ArcGIS functions and base layers to perform complex analysis. A check-in/check-out function allows clients to transfer their entire or select dataset(s) to their field devices. Furthermore, TreeWorks is fully customizable software—all data fields and reports can be modified to meet the client's needs.

Operating System & Special Requirements

Compatible with Windows 2000, Windows XP, or Windows Vista; ArcGIS is required.

Software Costs

The base price of TreeWorks is determined on a case by case basis depending on the customer's needs, contact a sales associate for more information. The base price includes free updates for the first year. Afterwards there is an annual maintenance fee of $600. This maintenance fee includes technical support and the cost of upgrades. TreeWorks provides clients with at least two upgrades each year.

Technical Support
On-site training is available, as well as online and phone technical support.

Contact Information
The Kenerson Group
2342 Main Street
Athol, MA 01331
Phone: 1-978-249-6495
Fax: 1-978-249-4784
Email: info@kenersongroup.com
Web site: http://www.kenersongroup.com

TRIMS Tree Inventory

Introduction to Software
TRIMS Tree Inventory was developed and is distributed by TRIMS Software International, Inc. It is a tree inventory software developed for municipalities, golf courses, parks, businesses, and campuses. According to TRIMS Software International, it can store an unlimited number of tree records.

Services
- Tree Inventories
- Track Maintenance History
- Production Monitoring
- Scheduling Field Crews

Additional Information
TRIMS Tree Inventory provides two different tree inventory systems: 1) *Municipal Street Tree Inventory* – trees are identified by the street address, and 2) *Golf Course & Park Tree Inventory* – trees are identified by a grid location or map. TRIMS Tree Inventory also comes with a 32-bit Open Database Connectivity allowing tree data files to be exported into Microsoft Excel, Access, and Word. TRIMS releases at least one upgrade per year to incorporate new technological and industry advances.

Operating System Requirements
Windows 2000, Windows XP, or Windows Vista

Software Costs
TRIMS Tree Inventory standard version comes as a 2-User Network System, priced at $1,495. There is an annual fee of $345 after the first year. Individual or multiple user and site licenses are available. Contact a sales associate for more information.

Technical Support
Step-by-step installation instructions are provided for standalone systems, network workstations, and servers. The purchase of TRIMS Tree Inventory includes the first year of technical support, customer service and upgrades. After the first year, there is a $345 annual fee to continue technical support and upgrades for the standard 2-user network systems and a $445 fee for multi-user and network license systems.

Contact Information
TRIMS Software International, Inc.
8987 W. Olive, #117, PMB 68
Peoria, AZ 85345
Phone: 1-800-608-7467 or 1-623-266-1943
Fax: 1-602-266-1945
Email: info@trims.com
Web site: http://www.trims.com

Urban Forest Inventory System (UFIS)

Introduction to Software
The UFIS was developed by Natural Resource Consulting, Inc. and is now distributed by its sister company, Natural Resource Technologies, LLC. According to Natural Resource Consulting, Inc. it can store an unlimited number of tree sites.

Services
- Tree Inventories
- Track Maintenance History
- GIS Mapping
- Production Monitoring

Additional Information
UFIS mapping features operate on a MapInfo platform. Existing maps can be imported from AutoCAD, ArcView, and other popular formats. Data can be exported into the i-Tree suite for further analysis.

Operating System Requirements
Windows 98, Windows 2000, or Windows Vista

Software Costs
The base price for UFIS is $6,000. The cost for upgrades varies depending on the product and client's needs. Contact a sales representative for more information.

Technical Support
Technical support is available by phone or email at support@nrtech.com.

Contact Information
Natural Resource Technologies, L.L.C.
PO Box 780603
Tallassee, Alabama 36078
Phone: 1-888-848-2146 or 1-334-252-0744
Fax: 1-334-252-0654
Email: info@nrtech.com or sales@nrtech.com
Web site: http://www.nrtech.com

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Olig, G.A and R.W. Miller. 1997. A Guide to Street Tree Inventory Software. http://www.na.fs.fed.us/spfo/pubs/uf/streettree/toc.htm (accessed 3/6/2009).

U.S. Forest Service. 2007. Tree Inventory and Management Software. http://www.na.fs.fed.us/urban/inforesources/inventory/InventorySoftwareListDetails.pdf (accessed 3/6/2009).

A Guide to Assessing Urban Forests

INTRODUCTION

Urban forests provide numerous ecosystem services. To quantify these services and guide management to sustain these services for future generations, the structure or composition of the forest must be assessed. There are two basic ways of assessing the structure or composition of the urban forest:

Bottom-up approach. Field-based assessments to measure the physical structure of the forest (e.g., species composition, number of trees)—typically used for strategic resource management or advocacy by connecting forest structure, functions and values with management costs, risks, and needs.

Top-down approach. Assessments of canopy cover using aerial or satellite images—used to determine amount and distribution of tree cover, potential planting space and other cover types.

These two approaches provide different types of urban forest information. The purpose of this guide is to outline the advantages, disadvantages and costs associated with various common assessment alternatives under these two approaches.

(28)

USDA United States Department of Agriculture

Forest Service

Northern Research Station

NRS-INF-24-13

THE BOTTOM-UP APPROACH: FIELD-BASED ASSESSMENTS

The bottom-up approach involves collecting field data on vegetation. It provides the most detailed information needed for urban forest management and to assess urban forest structure and its associated ecosystem services and values (Table 1). To aid in sampling or inventorying urban trees and forests, and for calculating their ecosystem services and values, the free i-Tree Eco and Streets models were developed (www.itreetools.org).

Advantages:

- Provides good estimates of basic forest information needed for management (e.g., number of trees and locations, species composition, tree sizes, tree health, risks)
- Provides estimates of numerous ecosystem services and their values
- Can be used for monitoring changes in forest composition and values

Disadvantages:

- Must collect accurate field data using technical metrics
- Cost of data collection

Cost:

Varies with size and scope of project. Volunteers, in-house crews and hired consultants have all been employed for collecting data. Hiring a consultant to carry out a typical i-Tree Eco sample of 200 plots could cost $40,000 at a contracted rate of $200 per plot. Costs would decrease with volunteers or student labor (e.g., $20,000 with students; even less with volunteers). Sampling intensity is determined by the user based on accuracy desired and resources available.

Accuracy:

Varies with sample size and accuracy of data collection; 200 one-tenth acre plots typically produces a relative standard error less than 15 percent for the total population estimate.

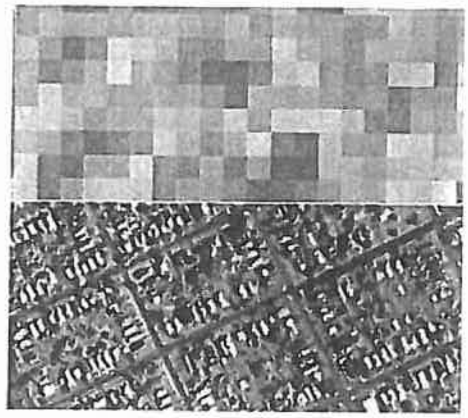
THE TOP-DOWN APPROACH: URBAN TREE CANOPY COVER ASSESSMENTS

There are three common top-down approaches for assessing urban tree canopy cover and all three methods will produce estimates of tree and other cover types in an area, but with differing resolution, costs, and accuracy. The three methods are:

- NLCD analyses
- High-resolution image analyses
- Aerial photo interpretation

NLCD analyses

The National Land Cover Database (NLCD) has tree and impervious cover maps (30-m resolution) for the entire contiguous 48 states with percentage tree and percentage impervious cover estimated for each pixel. These maps and data are available for free and can be loaded into the free i-Tree Vue program to estimate tree cover and general ecosystem services.



High resolution (below) vs. 30-m imagery.

Advantages

- Free
- Wall-to-wall coverage of lower 48 states
- Maps ecosystem services in addition to tree cover distribution

Disadvantages

- Relatively course resolution (cannot see trees)
- Better suited for state or regional analyses rather than city scale or below
- Typically underestimates tree cover, on average, by about 10 percent. That is, if tree cover is 30 percent, NLCD tends to estimate 20 percent
- Data from circa 2001 (updated maps are being developed)

Cost:

Free

Accuracy:

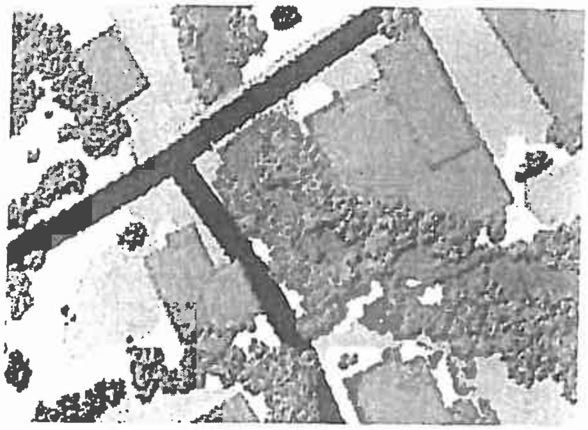
Varies with mapping zone, but tends to underestimate tree cover by about 10 percent on average; user can adjust canopy cover percentage in individual pixels in i-Tree Vue to improve accuracy.

High-resolution land cover

With this approach, land cover features are extracted from high-resolution aerial or satellite imagery using automated techniques. This process yields a detailed map of tree and other cover types for a given area. This approach is used for Urban Tree Canopy (UTC) Assessments. For more information go to: http://www.nrs.fs.fed.us/urban/utc/

Advantages

- Produces accurate, high-resolution cover map
- Complete census of tree canopy locations
- Integrates well with GIS



Example of high-resolution land cover map.

- Allows the data to be summarized at a broad range of scales (e.g., parcel to watershed), enabling tree canopy to be related to a host of demographic, planning, and biophysical data
- Locates potentially available spaces to plant trees
- Can be used to monitor locations of cover change
- The source imagery needed for the mapping is available for the entire United States free of charge from the USDA

Disadvantages

- Can be costly if the data are low quality or incomplete
- Requires highly trained personnel along with specialized software
- Significant effort and time needed to produce quality maps
- Change analyses can locate false changes due to map inaccuracies
- Does not include ecosystem services reporting

Cost:

Variable depending upon available data. Development of city cover maps are on the order of $5,000 to 40,000+ depending upon size of city and availability of source data.

Accuracy:

Depends on the processor and available data, but is typically 90 percent accurate for tree cover. The incorporation of additional data, such as LiDAR, and/or the implementation of manual corrections can increase the accuracy to over 95 percent. Error matrix of map can detail actual accuracy of the map.

Photo-interpretation

Uses digital aerial images and a series of random points that are interpreted to determine the cover type at each point center. This process produces statistical estimates of cover with a known error of estimation. A free tool (i-Tree Canopy) can be used to photo-interpret cover across the globe using Google Maps™. Photo interpretation has been used for accuracy assessments of the other top-down methods.

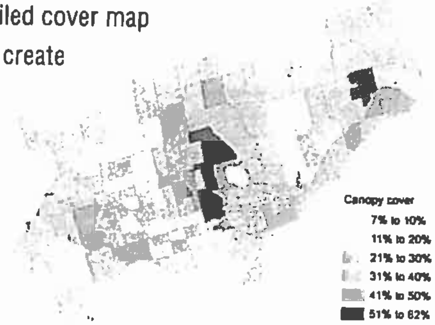
Advantages

- Low cost – most images can be acquired freely (e.g., Google Earth or from cities or counties)
- Cover assessment can be done quickly (e.g., available planting space, tree, impervious)
- Accuracy can be increased by adding more points and can be calculated quickly
- Can produce sub-area analyses and maps (e.g., tree cover by neighborhood)
- Multi-date paired imagery can be used to assess change

Photo-interpretation involves classifying randomly located points within preselected cover classes (e.g., tree, impervious, water).

Disadvantages

- Does not produce detailed cover map
- Photo-interpreters can create errors though misclassifications (training and quality checking are recommended)
- Leaf-off imagery can be difficult to interpret
- i-Tree Canopy interpretation limited to high quality Google images
- Poor image quality in some areas
- Resulting data cannot be summarized at multiple, user-defined scales



Neighborhood tree cover in Toronto, Canada, determined through photo-interpretation.

Cost:

At $10 per hour, cost is about 10 cents per point (e.g., 1,000 points = $100). Costs involve set up and interpretation time.

Accuracy:

A sample of 100 points will produce an estimate with a standard error of about 4.6 percent (assuming 30 percent canopy cover) and can be interpreted in about 1 hour. A sample of 1,000 points will produce an estimate with a standard error of about 1.4 percent (assuming 30 percent canopy cover).

Attachment 4

Table 1.—Summary of features of four types of urban forest analyses

Urban Forest Attribute	i-Tree Eco[a]	i-Tree Vue[b]	i-Tree Canopy[c]	Cover Map (UTC)[d]
Cover				
Amount or percent tree cover	✓	✓	✓✓	✓
Specific locations and distribution of tree cover		✓		✓✓
Amount or percent potential planting space	✓	✓	✓✓	✓
Specific locations and distribution of plantable space		✓		✓✓
Maps of tree cover and plantable space		✓	✓	✓✓
Urban Forest Composition and Management				
Total number of trees / tree density	✓✓			
Species composition	✓✓			
Diameter / size distribution	✓✓			
Species diversity	✓✓			
Species importance values	✓✓			
Leaf area and biomass	✓✓			
Tree health	✓✓			
Native vs. exotic composition	✓✓			
Invasive trees	✓✓			
Risk to insects and diseases	✓✓			
Ground cover attributes	✓✓		✓	✓
Ecosystem Services and Values				
Air pollution removal / human health	✓✓	✓	✓*	✓*
Carbon storage and annual sequestration	✓✓	✓	✓*	✓*
Effects on building energy use	✓✓			
Rainfall interception	✓✓			
Structural value	✓✓			
Mapping of ecosystem services		✓✓	✓*	✓*
Monitoring				
Change in tree cover	✓		✓✓	✓
Locations of tree cover change				✓✓
Change in species composition, services and values	✓✓			

✓ - procedure calculates attribute
✓✓ - recommended procedure based on resolution, accuracy, and cost
✓* - broad estimates of services could be calculated based on procedures in i-Tree Vue
[a]i-Tree Eco – free program to assess ecosystem services and values from field data
[b]i-Tree Vue – free program that uses NLCD cover data to map cover and estimate ecosystem services
[c]i-Tree Canopy – free photo-interpretation tool to assess canopy cover and monitor change
[d]Cover map - high-resolution cover maps generated as part of a UTC assessment

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31

APRIL 2017

City Trees Removed (upper/lower)		MARCH	YTD	2016
		21(20/1)	70(64/6)	143
w/ Lincoln bet. 3rd & 4th	20" Monterey pine			
e/ Dolores bet. 1st & 2nd	18" Monterey pine			
w/ Mission bet. 8th & 9th	25", 23" Monterey pines			
w/ Monte Verde bet. Ocean & 7th	4" Monterey cypress			
Forest Theater	29", 31", 15" Monterey pines			
n/ 8th bet. Santa Fe & Torres	10" Monterey pine			
n/ Santa Lucia bet. Rio & Mission	26" Monterey pine			
w/ Camino Real bet. 13th & Santa Lucia	14" oak			
w/ Guadalupe bet. 7th & Mt. View	14" monterey pine			
s/ Lorca Lane bet. CDM & Junipero	34" Monterey pine			
e/ Junipero bet. Lorcal &Vista	34" Monterey pine			
w/ Santa Fe bet. 8th & 9th	30" Monterey pine			
w/ San Carlos bet. 8th & 9th	29" Monterey cypress			
e/ San Carlos bet. 9th & 10th	32" Monterey pine			
n/ 9th bet. Monte Verde & Casanova	28" Monterey pine			
n/ 8th bet. Monte Verde & Casanova	25" Monterey pine			
s/ 12th bet. Junipero & Mission	34", 12" Monterey pines			
e/ Lincoln bet. Ocean & 7th	8" redwood			

City Trees Planted (upper/lower)	MARCH	YTD	2016
	2(2/0)	18(9/9)	46
15 gal. Monterey pine			
15 gal. Monterey pine			

Private Removal Permits (upper/lower)		6(4/2)	38(28/20)	117
e/ Dolores bet. 10th & 11th	9" Monterey pine			
w/ Junipero bet. 7th & 8th	18" Eucalyptus			
se 13th & San Carlos	22" Monterey pine			
s/ 6th bet. Carpenter & Guadalupe	10" Acacia			
w/ Lobos bet. Valley Way & 1st	33" Monterey pine			
e/ Dolores bet. 10th & 11th	24" Monterey pine			

Private Planting Requirements	1(1/0)	14(4/10)	68
5 gal. upper canopy			

(3H)

Construction Permits (remove/prune)		1(1/0)	2(2/0)	24
ne Torres & 10th	10" oak			
e/ Dolores bet. 1st & 2nd	14" incense cedar			

Construction Planting Requirements	0	1	13

Private Pruning Permits		1	7	24
w/ Lincoln bet. 3rd & 4th	4" Monterey pine limb			

Trees Under Care	
FOCF trees planted	81
City watered	260
City irrigated	23

City Pruning by contractors			
level I - total tree	0	0	22
level II - hazard /emergency	2	29	5
level III - specific purpose	0	0	0

Construction Finals	Planted

Trees planted / removed 2013 to date 299 / 588 (51%)