The University of Texas at Austin
Facilities Services

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Part of the Values at Work Series

Arbor Assets: The ROI of Campus Urban Forests

Introduction

The University of Texas at Austin's extensive grounds are home to a vast array of tree canopies lumbering across the campus' urban landscape, along with a variety of flora native to the sunny skies of the Southwest. From the towering branches of the massive Battle Oaks to the fruit-bearing orchard adjacent to Waller Creek, these trees bring a multitude of benefits to everyone in the university community.

UT Austin's South Mall trees provide a canopy of shade for students.

Yet when UT Austin's arborists discuss the benefits stemming from our urban forest, their conversations sound almost more like something that would take place in a classroom for the McCombs School of Business. Terms like return on investment ("ROI"), "valuation," "asset appreciation" and "green infrastructure" can be heard from the Landscape Services conference room in the Facilities Complex. That's because the conversation among professional arborists at universities has evolved as urban forestry programs have evolved.

Today's Urban Forestry Programs

Urban forests, as defined by the U.S. Forest Service, "include urban parks, street trees, landscaped boulevards, gardens, river and coastal promenades, greenways, river corridors, wetlands, nature preserves, shelter belts of trees, and working trees at former industrial sites. Urban forests, through planned connections of green spaces, form the green infrastructure on which communities depend." An urban forestry program also includes a focus on the proper care of trees, known in the field as arboriculture, and the International Society of Arboriculture (ISA) is the primary resource for "the art and science of tree care."

In recent years, these "planned connections of green spaces" have become more than landscaping. They are now considered part of a comprehensive asset valuation and management program in U.S. cities and universities. Previously, "trees and green spaces were always said to have 'intrinsic' value, but never really had monetary values associated with them," explains Jim Carse, manager of UT Austin's Landscape Services, "or in rare cases they have been treated as public infrastructure, such as roads and utilities."

Who helped bring about the change in the dialog? Carse says there are multiple sources. "The first I remember hearing of this paradigm shift was from projects like CITYgreen from American Forests, and the U.S. Forest Services' UFORE (the precursor to iTree). The basis for these programs was the idea that by completing an inventory of your tree assets and utilizing a geographic information system (GIS), you could assess the impact trees have on the environment—specifically in the urban cores where they really make an impact on water quality, erosion control, heating and cooling benefits and carbon storage."

Other significant players with a role in the shift include the arborists. These practitioners, who are responsible for managing the urban forests, are an increasingly substantial force as they are becoming more knowledgeable about the impact of trees and view them as a valued natural resource. According to the ISA, the standard-bearer for arborists, "the tree care profession has experienced rapid growth over the past decade and there is a significant amount of knowledge required to perform at the highest level," providing the impetus among arborists to obtain the ISA certification credentials.

UT Austin arborists celebrating National Arbor Day on campus and 10 consecutive years with Tree Campus USA designation

Another source for change comes from the people who live in the towns with urban forests. Their increased awareness and support of sustainability efforts in their communities includes appreciation of the many benefits of trees, evidenced by grassroots movements cropping up in neighborhoods across the country to keep trees intact as developers create new construction projects. Cities and groups across the country have also supported the importance of urban trees on many levels. Below are examples:

- TreeFolks, a local non-profit tree advocacy and education group
- City of Austin tree ordinance and development regulations

- Texas Trees Foundation – Dallas Urban Heat Island Report
- Tree City USA, a program of the Arbor Day Foundation

College campuses have shown their interest in managing trees as well. By engaging students, staff and faculty the Tree Campus USA program, delivered through the Arbor Day Foundation, strives to create a better understanding of the tree resources on college campuses across the country. UT Austin has held Tree Campus USA designation each year since the inception of the program in 2008. Along with the ISA, other major influencers include TREE Fund, which provides funding for scientific research, education programs and scholarships; private businesses who receive carbon offset credits; and the U.S. Forest Service, which developed the National Ten-Year Urban and Community Forestry Action Plan released in 2016. The plan was designed to "expand awareness of the benefits that our urban forests, including green infrastructure, provide to communities throughout the nation, and increase investments in these urban forest resources for the benefit of current and future generations."

Locally, the City of Austin also produced an Urban Forest Plan and partnered with the U.S. Forest Service on CompassLive, an inventory and assessment project for the city's tree canopy.

Impact of Trends on UT Austin's Urban Forestry Program

How did this growing movement affect The University of Texas at Austin and its continuously developing Urban Forestry Program? "A university's landscape is more than a pretty flower or the shade of a live oak tree," asserts Carse. "It's a functional asset that provides an immediate perspective as you enter campus. It forms the framework of the built environment. As stewards of its care, we go to great lengths to properly manage the different resources in the landscape, especially trees. We understand the many values trees provide to our campus community, which is why we decided to create a formal management program and assessment of these assets."

Further, the growth of the UT Austin campus, both in student enrollment and new building construction (capital projects), proved to the university's facilities management and campus planning staff that trees needed to be looked at with more importance; that they needed to be assessed from a safety perspective and as a campus asset. This shift has been reflected in master planning.

The 2014 Landscape Master Plan notes that the campus trees "are the essential feature of the campus landscape. Functionally, they provide shade; cleanse the air; intercept, conserve and store rainwater, secure the soil and moderate the campus climate. Visually, they provide naturalistic scenery to complement the dominant geometry of buildings. . . . When compared to the collective size of the campus buildings, paths, and streets, campus trees account for only a fraction of the visual 'content' of the campus; however, the value of trees in defining the quality of the campus far exceeds their simple quantitative contribution."

Similarly, the Sustainability Master Plan published in 2016 reinforces the Landscape Master Plan by emphasizing the functional value of the university's landscape, including its trees: "Landscape encompasses the aesthetic and practical makeup of campus trees, vegetation, the shape of the land, a diversity of fauna and unique features such as Waller Creek. . . . The continued health and ecological function of our landscape reflects our commitment to operational excellence."

Tree relocation in 2014 conserves valued asset while making way for construction of UT's Dell Medical School.

Landscape Services' Urban Forestry program has worked to inventory the trees across campus, gaining appraisal data from its 2007 audit. However, no ecosystem benefit data was collected until the university undertook an inventory and assessment in 2016, which underscored the value of the trees as assets to the university. There were many questions to be answered. Do we know the *comprehensive* value of our trees? Since trees continue to grow, shouldn't their assessed value appreciate over time? What benefits do we derive from these assets? Can we quantify these benefits, and if so, how? This is especially relevant when trees are removed during necessary and significant construction projects on campus. In other words, what is the impact to the university, in terms of cost, when it loses specific trees? Is this cost taken into consideration? And what standards are used to determine the decisions made in removing those trees? As stewards of the campus, Landscape Services realized that it had a responsibility to provide campus planners and decision makers with the information needed to make more informed decisions with regard to the campus urban forestry assets.

A comprehensive plan to address the missing information was devised. Carse spoke to and received approval and direction from Facilities Services (FS) senior leadership on actionable steps to capture the data in order to develop and support a conversation around trees that was green—not just in the environmental sense, but in terms of defined benefits and dollars. The steps included:

1. Complete and document an inventory of the trees on the Main Campus that are at least three inches in diameter at breast height (DBH) and have one erect perennial stem. In the Waller Creek corridor, trees under eight inches DBH were not inventoried.
2. Research the industry's professional standards to identify, describe and assess the multiple benefits of UT's urban forest and their corresponding dollar values.
3. Recommend and implement management practices.

4. Develop an online tool to document and better manage the tree inventory and assessments data and to make the information easier to share with stakeholders.
5. Share knowledge with university faculty and students for academic purposes.
6. Develop and document construction standards and specifications for the proper management of UT Austin's urban forest.

UT Austin's Tree Inventory and Assessment Action Plan Takes Root

Step 1 – Inventory the trees and analyze the data

The university commissioned an inventory of trees on the main campus in 2016. The inventory gathered information about each tree, including species, size, condition and geographic location in an electronic, GIS format. Davey Resource Group (DRG) conducted the inventory over a period of four months, then analyzed the data using i-Tree *Streets*. DRG reported results to the university in *Urban Forest Resource Analysis, The University of Texas at Austin*. The inventory identified 4,892 trees of over 100 different tree species across the main campus and noted that 109 acres of tree canopy cover 25 percent of the campus.

Gathering information about UT's campus trees in 2016

Step 2- Assess the value of the trees based on key benefits

Based on inventory findings about the condition of the campus forest (tree population and species, size, placement and condition), the current replacement value of the 4,829 trees in UT Austin's urban forest is assessed at over $25.4 million. The average replacement value per tree is $5,622. The analysis assumes the value of a tree is equal to the cost of replacing the tree in its current condition with a tree of the same variety and diameter or multiple trees of the same variety that collectively are equal in diameter to the tree to be replaced. DRG relied on the International Society of Arboriculture Texas Supplement to the Council of Tree & Landscape Appraisers *Guide for Plant Appraisal* to assess the replacement value of the campus urban forest

The report states, "UT-Austin's trees represent a vital component of the campus infrastructure and an asset valued at over $25.4 million—an asset that, with proper care and maintenance, will continue to increase in value over time." The replacement value describes the value of a tree population or specific tree at a given time. In addition to replacement value, the inventory and analysis also allow calculation of the economic value of the benefits of the urban forest in terms of air quality, environmental health, economic development and psychological health. The i-Tree *Streets* analysis model uses regional references, cities and local community attributes, such as median home values and local energy prices, in quantifying benefits. (More details about the methods used to calculate and assign monetary value to each the campus benefits are included in the report.)

Benefits Quantified

- ***Electricity and natural gas reduction.*** Trees modify climate and conserve energy by reducing the amount of radiant energy absorbed and stored by hardscape. They convert moisture to water vapor, thereby cooling the air. Plus, they reduce wind speed and movement of outside air into buildings, helping to save annual heating costs. Annual electricity and natural gas savings at UT Austin from shading and climate effects of trees is equal to 541 MWh (electricity valued at $32,984) and 18,301 therms (natural gas valued at $814,597), for a total retail savings of approximately $847,597—an average of $176 per tree.
- ***Atmospheric carbon dioxide reduction.*** Urban trees directly reduce atmospheric CO_2 by sequestering it and indirectly by lowering the demand for heating and air conditioning, thereby reducing emissions associated with power generation and natural gas consumption. Using the Urban Forest Project Reporting Protocol which, among other things, establishes methods for calculating greenhouse gas reductions, the campus trees were found to reduce atmospheric CO_2 by 1,231 tons, valued at $18,467, with an average value of $3.82 per tree.

- ***Air quality impacts.*** Urban trees improve air quality by absorbing pollutants such as ozone and sulphur dioxide through leaf surfaces; intercepting particulate matter such as dust, pollen and smoke; reducing emissions from power generation by reducing energy consumption; increasing oxygen levels through photosynthesis; and by transpiration of water and providing shade, which lowers air temperatures, thereby reducing ozone levels. Each year, 1.3 tons of nitrogen dioxide, sulfur dioxide, small particulate matter and ozone are absorbed by campus trees, valued at $11,640, with the live oak population accounting for 63% of these benefits. The energy savings provided by trees have the additional indirect benefit of reducing air pollutant emission that result from energy production. Altogether, 4,005 pounds of pollutants, valued at $14,007, are avoided annually through the shading effects of trees. Biogenic volatile organic compound (BVOC) emissions from trees, which negatively affect air quality, must also be considered along with the benefits. Approximately 8,051 pounds of BVOCs are emitted annually from campus trees.
- ***Stormwater runoff reduction.*** Tree leaves and branches intercept rainfall, their roots increase the ability of soil to absorb rainfall, and their canopies help reduce soil erosion. Campus trees intercept more than 20.5 million gallons of stormwater annually for an average of 4,250 gallons per tree. The dollar value to campus is $203,213—an average of $42 per tree.
- ***Aesthetic, property value and socioeconomic benefits.*** As the report notes, "Trees provide beauty in the urban landscape, privacy to homeowners, improved human health, a sense of comfort and place, and habitat for wildlife. One source for the report cites research showing trees even promote better business. For the report, aesthetic benefits reflect the increase in leaf area for each species population over the course of a single year. Using this approach and i-Tree *Streets* analysis, the total annual benefit from the campus trees is calculated at $499,159, an average of $103 per tree.

Overall Value of Benefits

Annually, the UT Austin campus trees provide cumulative benefits to the community. DRG calculates that these benefits are worth $1.5 million, a value of $319.67 per tree.

Step 3 – Recommend and implement proactive management practices

In addition to documenting the current state, replacement value and benefits of the main campus trees, the inventory establishes benchmarks for future decisions about managing this urban forest resource. Also included are data that may be used to help pursue funding and collaborative relationships, as well as for developing a long-term forest management plan.

Further, as the DRG report states, "Performance data from the analysis [of the inventory] can be used to make determinations regarding species selection, distribution, and maintenance policies," and data can "provide a strong basis for making informed management decisions."

Recommendations

The *Urban Forest Resource Analysis* brought forth several recommendations for managing UT Austin's urban forest, noting that "Trees are one of the few community assets that have the potential to increase in value with time and proper management." Recommendations include these:

- Increase species diversity.
- Use all available planting sites.
- Implement a regular pruning cycle.
- Protect existing trees; inspect regularly.
- Continue to maintain the inventory database (described in Step 4, below).

Implementation

Landscape Service's urban forestry team began implementing recommendations by first inspecting those trees identified as needing immediate attention, primarily for safety concerns. The team removed some trees and trimmed others.

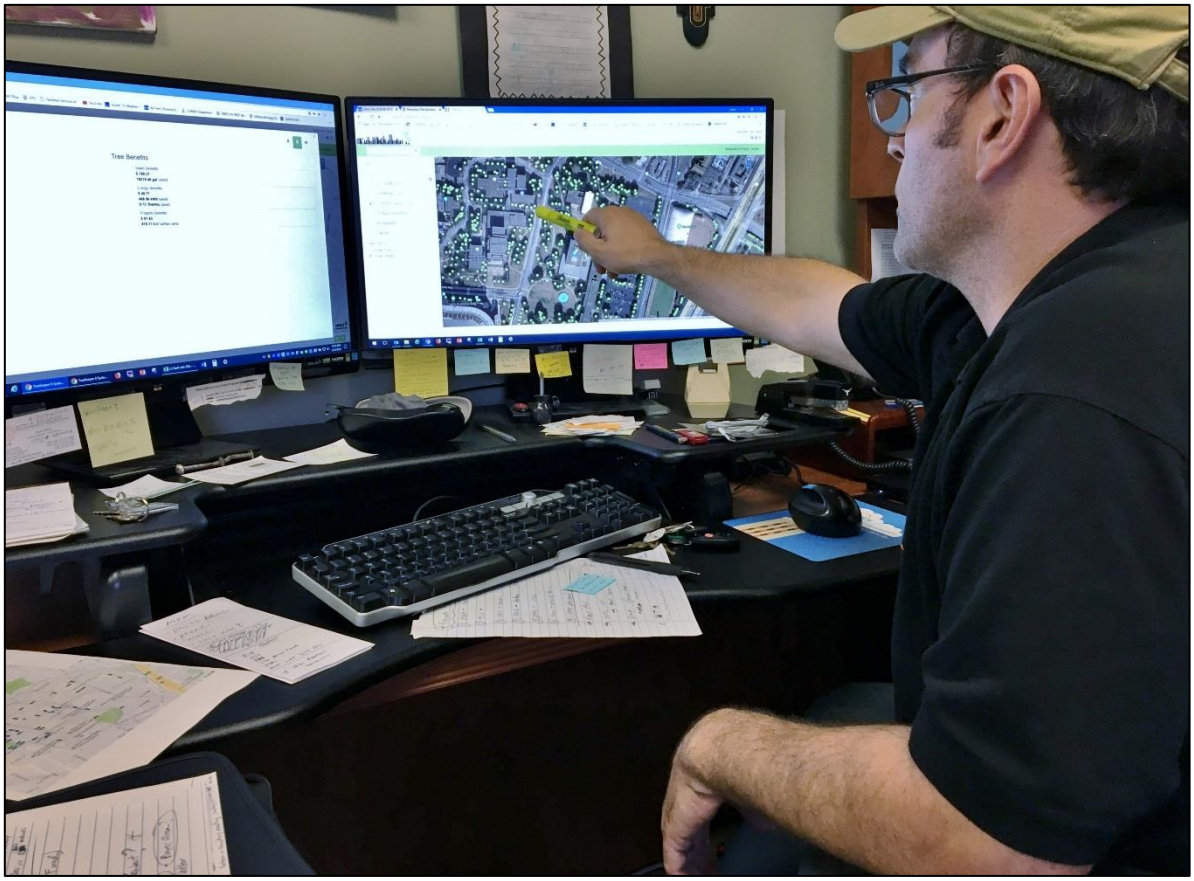
Landscape Services Manager Jim Carse inspecting inventoried tree, using iPad

For those trees not needing immediate attention, but identified as having maintenance needs, the urban foresters remove dead limbs, inspect cavities, air spade buried root flares and carry out other tasks. This effort is ongoing.

The report identified available planting areas, which supports Landscape Services in efforts to increase species diversity and use available planting sites. “We now know potential sites for volunteer events and memorial trees,” says Carse. These sites can accommodate several varieties of recommended trees to increase diversity.

Step 4 – Develop online tool to manage tree data and document assessments

The inventory provided the basis for an online tool developed by DRG that the university’s urban forestry team uses to manage tree data and document assessments. Called TreeKeeper8, this tool aids Landscape Services with decision-making about tree planting and maintenance and is accessible on mobile devices.



Carse accessing tree data on TreeKeeper8

Step 5 – Leverage data to academic units

TreeKeeper8 is also accessible to the public from the Urban Forestry section of the Facilities Services website (see "Tree Inventory & Assessment") and can be used by students and faculty for research. TreeKeeper8 provides basic information including tree tag number, species, diameter, height and GIS coordinates for each tree in the database.

Faculty members in the university's College of Natural Sciences are using TreeKeeper8 for geological sciences and integrative biology research. For example, one professor has her students using TreeKeeper8 to study bald cypress trees of a certain size growing in Waller Creek, an urban stream that runs through a section of campus. The tool also allows anyone to identify a tree on campus about which he or she is curious, or simply to learn more about a tree of interest.

TreeKeeper8 data can be used beyond UT Austin. The Waller Creek Framework Plan, a collaboration of the university with the City of Austin and environmental groups, seeks to integrate Waller Creek more into community life on campus and beyond. Data from TreeKeeper8 is being shared to support the planning effort.

Step 6 – Research and develop UT standards

The timeline for developing construction standards related to trees was driven by UT Austin's Project Management and Construction Services (PMCS) department updating campus construction standards in 2015. Recognizing the need for tree standards, Landscape Services worked with PMCS and Campus Planning to develop the standards. Published in April 2016, the university's Tree Preservation and Care Standards and Specifications were formed, in part, by incorporating aspects of the City of Austin tree protection code and heritage tree code. Those codes were based on U.S. Forest Service research; it was felt that there was no need for UT Austin to start from scratch in developing its own standards and specifications.

The tree inventory supports the campus standards for assessing and discussing trees early in projects, at pre-construction. Projects must work with Landscape Services' urban forestry team, including using UT Austin's tree tag numbers to identify trees. By providing the GIS location of trees, the inventory enables designers to plan buildings based on the trees that the university wants to keep. Among other data, the inventory provides critical root zone information; the standards require projects to preserve or mitigate at least 50 percent of the root zone of trees more than eight inches in diameter.

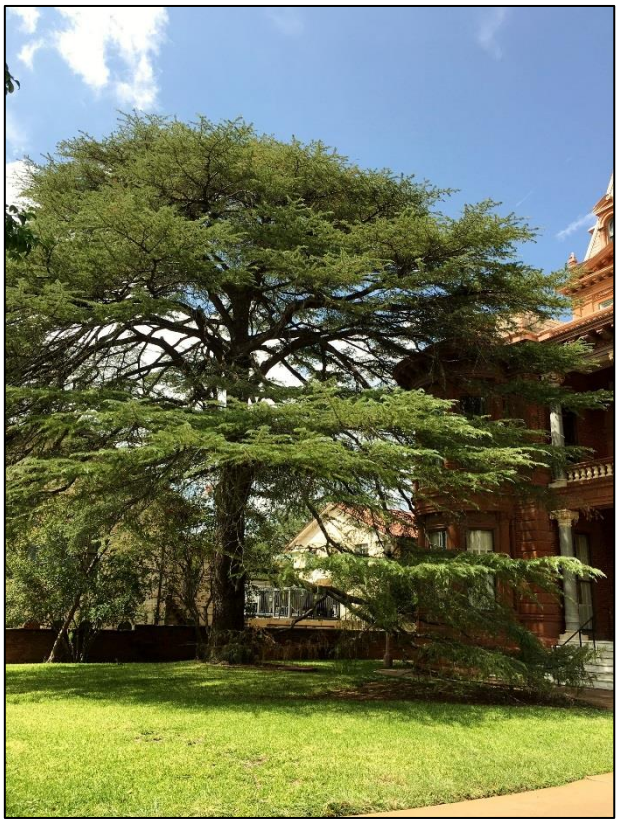
"If a project is in early stages, we can use our data to develop an assessment of the trees on the site to share with the designer and project team," says Carse. In addition to critical root zone, that assessment can include number of trees, their size and species, and information that may be useful for the specific site. "The inventory can give the project team a lot of data,

even details as specific as the condition of the tree and whether a tree located over a planned utility line is in poor condition and can be removed," he notes.

Carse also points out the necessity for Landscape Services to maintain the inventory. "If a tree is removed, we have to update that in the inventory. We have to keep it current so that we can accurately inform projects."

Conclusion

Carse affirms the multiple benefits of the tree inventory and report to UT Austin. "If you don't know what you have, you can't manage it," he asserts. With the tree inventory, "in two minutes I can have details on any tree on campus." He notes that having current, accurate and complete information connects directly to safety and helps his team manage trees for that vital aspect. From a financial perspective, "data about the value of the trees give us a leg to stand on when we ask for funding." Benefits extend beyond UT Austin with the ability of the public to gain information about the many contributions of trees and their value.



UT Austin's valued state champ deodar cedar at Littlefield House.

The inventory and report would not have been possible without the university's commitment to its urban forest, and the ongoing, dedicated efforts of Landscape Services' tree experts. As DRG's *Urban Forest Resource Analysis* report concludes, the "Landscape Services Department has demonstrated that campus trees are a valued community resource, a vital component of the campus infrastructure, and an important part of the university's identity. . . . A continued commitment to planting, maintaining, and preserving these trees will support the health and welfare of the campus and community at large."

For more information about The University of Texas at Austin's urban forestry or Landscape Services programs, contact Jim Carse, Manager of Landscape Services, at jim.carse@austin.utexas.edu or at (512) 475-7756.

For media inquiries, contact Laurie Lentz at laurie.lentz@austin.utexas.edu or at (512) 471-2273.