

University of North Texas at Dallas Campus Tree Inventory & Ecosystem Service Benefits Report

November 2016



TEXAS TREES
FOUNDATION

Acknowledgements



The Mission of the Texas Trees Foundation is to preserve, protect, beautify and expand parks and other public natural green spaces, and to beautify public streets, boulevards and rights-of-way by planting trees and encouraging other to do the same through educational programs that focus on the importance of building and protecting the “urban forest” today and for generations to come. The vision is shared nationally, but efforts and loyalties are focused among communities in North Central Texas.

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Plant-It Geo (PG) is a geospatial consulting and software development company specializing in innovative solutions for natural resource management. PG offers a full range of services including GIS, remote sensing, cost/benefit analysis, urban forest planning, water resources analysis, decision tools, and web-based software. They are recognized nationally as a trusted source in progressive geospatial analysis and reporting related to urban forestry and green infrastructure.

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Acknowledgements



The University of North Texas at Dallas assessment would not have been possible without the support and assistance of the following individuals:

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 Glenda Balas PhD, Interim Provost
 Dan Edelman PhD CPA, Executive VP for Administration/CFO
 Stephanie Holley, Vice President of Enrollment Management
 Monica Williams, PhD, VP, University Advancement
 Randy Jolly, Associate Vice President, Marketing & Communications
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BACKGROUND

The University of North Texas at Dallas (UNT Dallas), located in the southern region of Dallas, Texas rests on 264 acres just north of Interstate 20 between Interstate 35 and 45. Surrounded by 800 acres of natural escarpment, the UNT Dallas campus sits in a unique part of Dallas County. With the Great Trinity Forest to the east and the Eastern Cross Timbers to the west, the UNT Dallas campus has traits of both very different and specific eco-regions.

With over 68,000 trees spread over 264-acres and with less than 10% of UNT Dallas campus developed, a comprehensive understanding of the campus urban forest is an important step. By understanding the structure, function, and associated values of the natural landscape, it will help promote sound management and planning, and create a clear vision of how the UNT Dallas campus will look and feel in the future.

In the winter of 2015, a partnership between UNT Dallas and Texas Trees Foundation was established to perform an assessment of all trees on campus; both in the built environment and the natural undeveloped space. To accomplish this, Texas Trees Foundation (TTF) utilized several urban forestry assessment tools. The various assessments when combined provide the most accurate and detailed picture of the urban forest available. The assessments completed were:

- 1) **i-Tree Eco Assessment:** i-Tree is one tool in a suite of tools that provides a broad picture of the entire urban forest. i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that can be used to provide an urban and community forestry analysis and environmental benefits assessment. i-Tree tools help communities and universities of all size to strengthen urban forest management and advocacy efforts by quantifying both the structural and environmental services trees provide.
- 2) **Urban Tree Canopy (UTC) Assessment:** UTC assessments utilize detailed land cover data derived from high-resolution aerial imagery to determine a very precise and accurate picture of the extent of the tree canopy, impervious surface, and available planting spaces.
- 3) **Complete Inventory of all planted trees:** Utilizing specialized tree inventory software, Texas Trees Foundation evaluated each planted tree on campus. The location of the tree, tree species, height, diameter, recommended maintenance treatments, and other characteristics of each tree were evaluated and cataloged using an online tree inventory database. This online database allows individuals to accurately place trees over aerial imagery and document tree characteristics and record recommended maintenance for public safety as well as overall tree health and vitality.

EXECUTIVE SUMMARY

University of North Texas at Dallas (UNT Dallas) urban forest plays a crucial role in the livability and sustainability of all those that visit each year. UNT Dallas 68,040 trees impact everything from economic development to the overall health of the people that work and learn on campus every day.

UNT Dallas' 68,040 trees result in a tree canopy cover of 43%. The remainder of the campus is covered in non-canopy vegetation and impervious surface, such as buildings and parking lots, at 35% and 10% respectively. Of these 68,040 trees over 55% are one species. Increased tree diversity in landscapes as the University grows will help to increase species diversity and lower this number. With so much room to grown UNT Dallas faces many challenges. While at the same time is provided the unique opportunity to shape the campus for generations to come.

This report describes, in detail, the work that was completed to evaluate the current condition and value of the trees on the UNT Dallas campus. It also integrates the results of the campus inventory as well as the results of the Eco study and offers recommendations for the care and maintenance of the trees on campus and lays the framework for making UNT Dallas a greener, cleaner, cooler campus.



KEY FINDINGS

The key findings for the 2016 UNT Dallas Urban Forest Resource Assessment are below. This data represent a snapshot of both the structural and functional values of the universities urban trees. They are provided to aid in the planning and management of this increasingly important resource. The quantification of the benefits of UNT Dallas urban forest should serve as a reliable advocacy tool to help educate university leaders and the student body about the importance of investing in professional planning and management of UNT Dallas' trees.

- UNT Dallas has a total of 68,040 trees on campus valued at \$53.5 million.
- UNT Dallas average tree canopy is 43%.
- UNT Dallas' most common tree species are Eastern Red Cedar, Cedar Elm, Green Ash
- UNT Dallas trees provide nearly \$100,000 every year in environmental benefits.
- Trees cleaned the air by storing 11,662,000 pounds of carbon.
- Trees provided annual energy savings of \$3,510 annually.
- Trees on the UNT Dallas campus mitigate 3,517,157 gallons of rainfall each year, for an annual savings of \$31,429.

Ton: short ton (U.S.) (2,000 lbs)

Carbon storage: the amount of carbon bound up in the above-ground and below-ground parts of woody vegetation

Carbon sequestration: the removal of carbon dioxide from the air by plants

Carbon storage and carbon sequestration values are calculated based on \$71 per ton

Pollution removal value is calculated based on the prices of \$1136 per ton (carbon monoxide), \$1671 per ton (ozone), \$528 per ton (nitrogen dioxide), \$165 per ton (sulfur dioxide), \$8897 per ton (particulate matter less than 10 microns and greater than 2.5 microns), \$71337 per ton (particulate matter less than 2.5 microns)

Energy saving value is calculated based on the prices of \$114.9 per MWH and \$10.15 per MBTU

Rainfall Interception is calculated by the price \$0.067/ft³

Structural value: value based on the physical resource itself (e.g., the cost of having to replace a tree with a similar tree)

Monetary values (\$) are reported in US Dollars throughout the report except where noted

For an overview of i-Tree Eco methodology, see Appendix I.

INTRODUCTION

The University of North Texas at Dallas is in the southern region of Dallas and was founded in 2000. Though the 264-acre campus is still relatively young, UNT Dallas continues to set record enrollment with over 2,600 students enrolled during the Spring of 2015. In addition to being a thriving educational institute, UNT Dallas continues to set the bar for environmental sustainability. Whether it is the green roofs and water-wise landscaping, taking the lead to bring DART to campus, or having the foresight to include environmental sustainability in their 2005 Campus Master Plan; UNT Dallas is a leader in their field.

Over the past decade, there has been an increase in both the knowledge of ecosystem services and social benefits of urban forests as well as the availability of quantitative tools, such as i-Tree, for the measurement and dispersal of reputable information regarding the importance of the urban forest. The introduction of these new tools has allowed for the quantification of the valuable assets that urban forests provide. Since the introduction of these new quantitative tools for measuring tree benefits, nearly 827 international and 773 national assessments have been produced (as of January, 2012). UNT Dallas has recognized that an inventory of the trees on their campus will highlight the benefits and management needs that the trees require or provide. Commissioned in part to quantify the monetary value and quality of life values associated with urban trees, this study highlights the importance UNT Dallas leaders have placed on their campus tree population. The results will enable campus leaders to continue enhancing the University's urban forestry program and help guide them as they grow.

"The master plan for University of North Texas at Dallas provides a vision for a new university in the 21st century. It is intended to be a model for new campuses in terms of higher education delivery, campus design, community partnerships and environmental stewardship."

*- The University of North Texas Dallas
Campus Master Plan, 2015*

METHODOLOGY: CAMPUS TREE INVENTORY

Data was collected on the UNT Dallas campus from June to August, 2016 using a Plan-It-Geo tree inventory software known as “TREE PLOTTER”. It has the capability to incorporate aerial imagery and other GIS based software (ArcMap, etc.) to precisely identify where trees are located in the landscape through the use of Latitude and Longitude coordinates.

Once a tree was placed in the approximate location on the aerial imagery overlay, the coordinates are automatically recorded within the program. These coordinates are essential as it allows crews to be dispatched for geo-referencing or maintenance to be performed. An assessment of the current health of the tree, the diameter of the trunk (DBH) and height of the tree, location of tree (front of campus, left, rear or right) as well as any defects and recommendations was completed for each tree on the UNT Dallas campus.



All planted shade trees and ornamental tree species were included in the survey. All the trees were also assessed to determine what maintenance, if any, needed to be scheduled. Below is a list of attributes and maintenance recommendations collected for each tree:

- Species
- Height (feet)
- Diameter at breast height (DBH) (Inches)
- Latitude and Longitude
- Observations
- Management recommendations
- Health condition of tree
- Location on campus

METHODOLOGY: I-TREE ECO

In June, 2016 with the assistance of students from Dr. Donna Hamilton's Remote Sensing and GIS class and Dr. Narayan Ratna's science methods class at UNT Dallas, other measurements were collected using pen and paper, and then later input and processed through a program called i-Tree Eco. i-Tree Eco is a software application that is designed to use field data from either complete inventories or randomly located plots throughout a specified area to quantify the forest structure, environmental effects as well as the value to communities.

Once the plots were randomly generated, the students and a Texas Trees Foundation intern or forester found plot center using either aerial imagery or a handheld GPS unit. Once the plot center was determined, using a 100-foot tape measure, a 37.2-foot radius boundary was made to create a 1/10th acre plot. Within this plot radius, several measurements were recorded for every tree that was larger than two inches in diameter. The measurements and data that were recorded are listed below:

- Tree Status (whether the tree was ingrown or planted)
- Direction and distance from plot center
- Species
- Diameter at breast height (DBH) (inches)
- Total height of tree
- Height of the live top of the tree (highest point where green vegetation is present on the tree)
- Crown base (height of the lowest portion of the canopy)
- Crown width
- Percent of canopy missing
- Percent of dieback within the canopy
- Percent of the canopy that falls over impervious ground
- Crown Light Exposure (how many sides of the canopy is receiving at least 10% sunlight)
- Distance and direction to the nearest building (only recorded if the tree is at least 20 feet tall and 60 feet within a building with an air-conditioned building)



TREE ASSESSMENT RESULTS

The urban forest of UNT Dallas has an estimated 68,040 trees covering the 264-acres, giving the campus a tree cover of 43%. This section presents the key findings and results of all the assessments, including the canopy analysis, i-Tree Eco, and campus tree inventory. These results, or metrics, provide a benchmark of the current forest cover and can assist in developing a strategic approach towards identifying future planting and management areas.

URBAN TREE CANOPY ASSESSMENT RESULTS

Ground cover refers to the physical and biological cover over the surface of the land, including water, vegetation, bare soil, and/or artificial structures. It differs from land use, which is the physical use of the site. Urbanization tends to increase the rate of ground cover change, making sustainable land practices essential to the sustainable management of the urban forest.

This assessment found that 43% of UNT Dallas' campus was covered by tree canopy, 35% was non-canopy vegetation, and 10% was impervious. As the campus continues to expand the amount of impervious surface will only increase, this can cause issues such as an increase in the urban heat island (UHI) effect and flash flooding. Figure 1 below illustrates the detailed campus land cover.

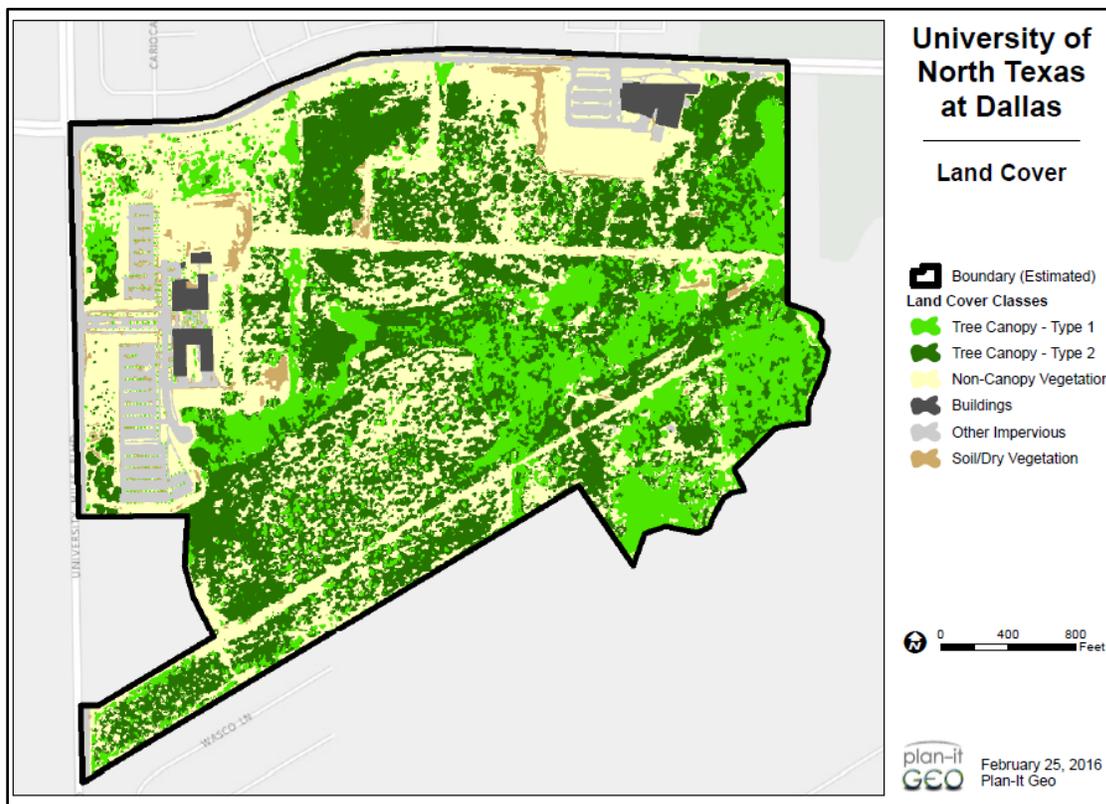


FIGURE 1: LAND COVER CLASSIFICATION OF ENTIRE UNT AT DALLAS CAMPUS

POTENTIAL CANOPY CHANGE

As part of this assessment we looked at the potential impact of future campus expansion. Though it is impossible to predict how the campus will grow and change over time, we used the 2005 Campus Master Plan as a base to demonstrate one potential outcome if there is no clear set of guidelines and procedures in place to help guide environmental stewardship on campus.

Canopy cover in 2016 equals 158 acres, covering 43% of the campus. When the current master plan is over-laid with the canopy, and assuming no trees can be preserved during construction. There are 111 acres of canopy at risk of being lost, accounting for 70% of the overall canopy on campus. With such a large percentage of the overall canopy at risk it is imperative that measures be taken during construction to preserve the biggest and best trees. This combined with an aggressive planting strategy will help to balance the canopy over time. Setting clear canopy cover goals for the campus now will help to inform decisions later for tree preservation and landscaping.

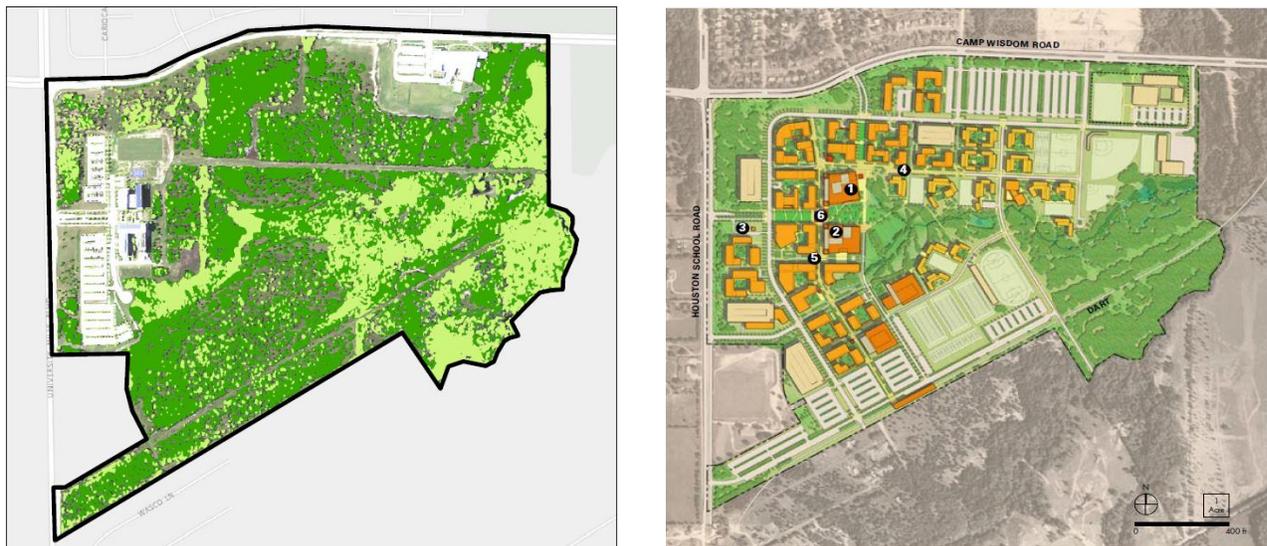


FIGURE 2: UNT DALLAS 2005 CAMPUS MASTER PLAN ALONGSIDE 2016 URBAN TREE CANOPY ANALYSIS OF LAND COVER CLASSIFICATIONS

FIGURE 3: TREE CANOPY HIGHLIGHTED IS AT RISK FROM FUTURE BUILD-OUT.

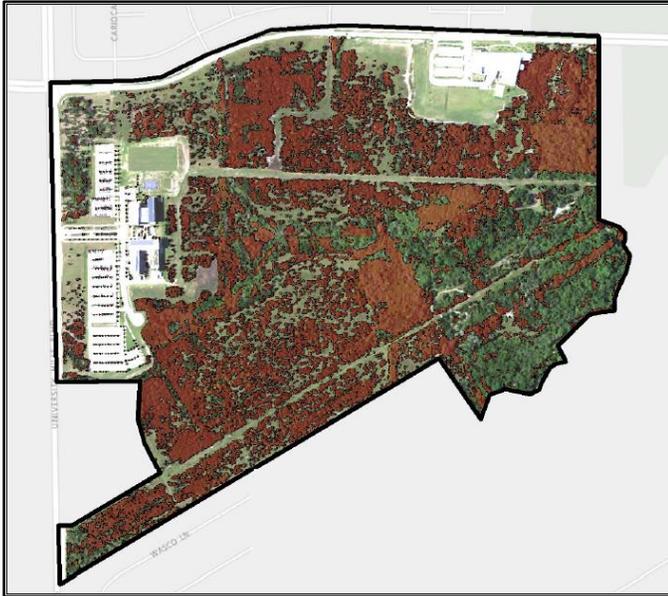
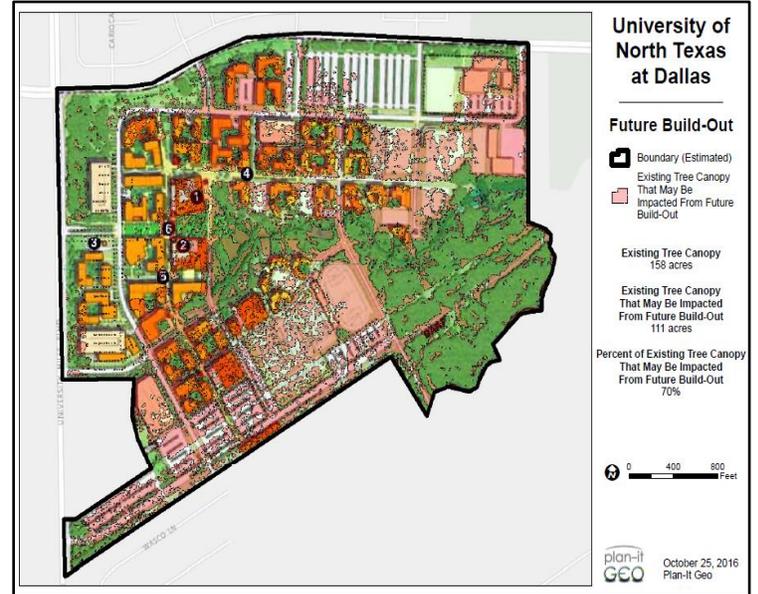


FIGURE 4: OVER-LAY OF CAMPUS MASTER PLAN WITH CANOPY COVER



TREE INVENTORY & ECO ASSESSMENT RESULTS

While the UTC assessment focused on the overall canopy cover for the campus using high resolution imagery, the i-Tree Eco assessment and tree inventory requires direct measurements through the collection of field data to better understand the species, size, health and overall composition of UNT Dallas urban forest.

Urban forests by nature have a higher tree diversity than surrounding native landscapes, often with a mix of native and exotic tree species. The level of species diversity can have major implications on resource management.

Increased tree diversity, for example, can minimize the overall impact or destruction by a host-specific insect or disease. However, it can also pose risk to native plants if some of the exotic species are invasive plants that potentially out-compete and displace more desirable native species.

At UNT Dallas, we separated the planted, or “landscape” trees, from the native trees. The top three species of trees that have been planted on campus are cedar elm (*Ulmus crassifolia*), making up 43% of the entire canopy on campus, while Shumard oak (*Quercus shumardii*) comprises 28%, and live oak (*Quercus virginiana*) tallies 13%. In total at UNT Dallas the *Ulmus* genera (elms) accounts for 36% of the canopy while the *Quercus* genera (Oaks) makes up 44.9% of the entire canopy. The fact that the percentage of trees in the *Quercus* genera is that high is a cause for concern because of the presence of Oak wilt (*Ceratocystis fagacearum*) in the Dallas area.

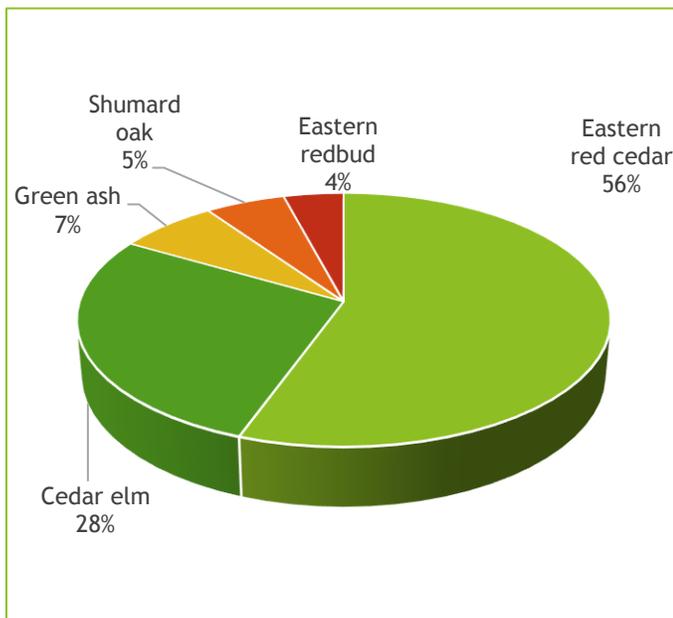


FIGURE 5: TOP FIVE SPECIES FOUND ON THE ENTIRE PROPERTY OF UNT DALLAS

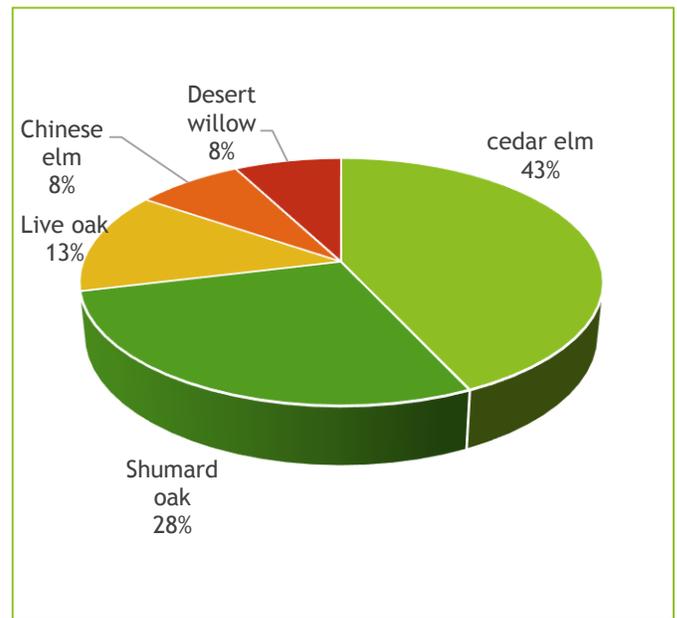


FIGURE 6: TOP FIVE SPECIES PLANTED ON CAMPUS

However, the entire property results are slightly different than the planted campus trees. The Eco study shows that eastern red cedar (*Juniperus virginiana*) accounts for 56% of the entire canopy, with cedar elm and green ash (*Fraxinus pennsylvanica*) at 28% and 7% respectively. This is an accurate picture of the native species population represented in southern Dallas. Eastern red cedar and green ash are fast growing, pioneer species which colonize an area and lead to larger trees eventually. These results also resound that there are areas where removing these pioneer species and planting longer lived, bigger stature trees makes more sense. By using this data, best management practices can be made so that pockets of oak and elm can be saved and protected during the construction of the rest of the campus and a more resilient and sustainable landscape can be produced.

For a further breakdown of the condition classes and maintenance needs for the planted trees see Appendix II.

**Santamor (1990) describes the ideal proportion of family, genera and species which should reside in each area. Santamor recommends that no more than 30% of the entire population should be comprised of the same family of trees (e.g. Fagacea oak and beech family); no more than 20% should be comprised of the same genera (e.g. oak trees); and no more than 10% should be comprised of the same species (e.g. Shumard red oak).*



RELATIVE TREE AGE AND SIZE

Tree diameter is a relatively good tool to determine the age distribution of a stand of trees. Typically, in an urban setting, a mix of ages and sizes is preferred. Because of the everyday stress that urban trees are put through, tree mortality can be more frequent than in a forested setting. To prevent a large age gap from occurring once the mature trees begin to perish, it is essential to have a proper mix of tree ages, e.g. small trees become big trees and produce more seedlings, thus a cycle is created.

UNT Dallas' tree canopy mostly consists of two age classes (Figure 7); one consisting of medium sized trees, and the other consisting of smaller trees. Over 70% of the trees on campus are within 6-12 inches DBH, while about 27% falls within 3-6 inches. These numbers could be a cause for concern in the future. When there is a high percentage of trees in the larger diameter classes, issues can occur about mortality and replacement. There might not be enough younger trees to replace the older trees as they begin to die. *Richards (1983) describes the ideal age distribution for long lived, well adapted trees as the following: 40% of the tree population to be less than about 6 inches, 30% of the population to be within 6-15 inches, 20% within 15-23 inches, and 10% above about 23 inches. For long term sustainability, both large and small trees should be planted on campus as construction projects begin. See Appendix III.

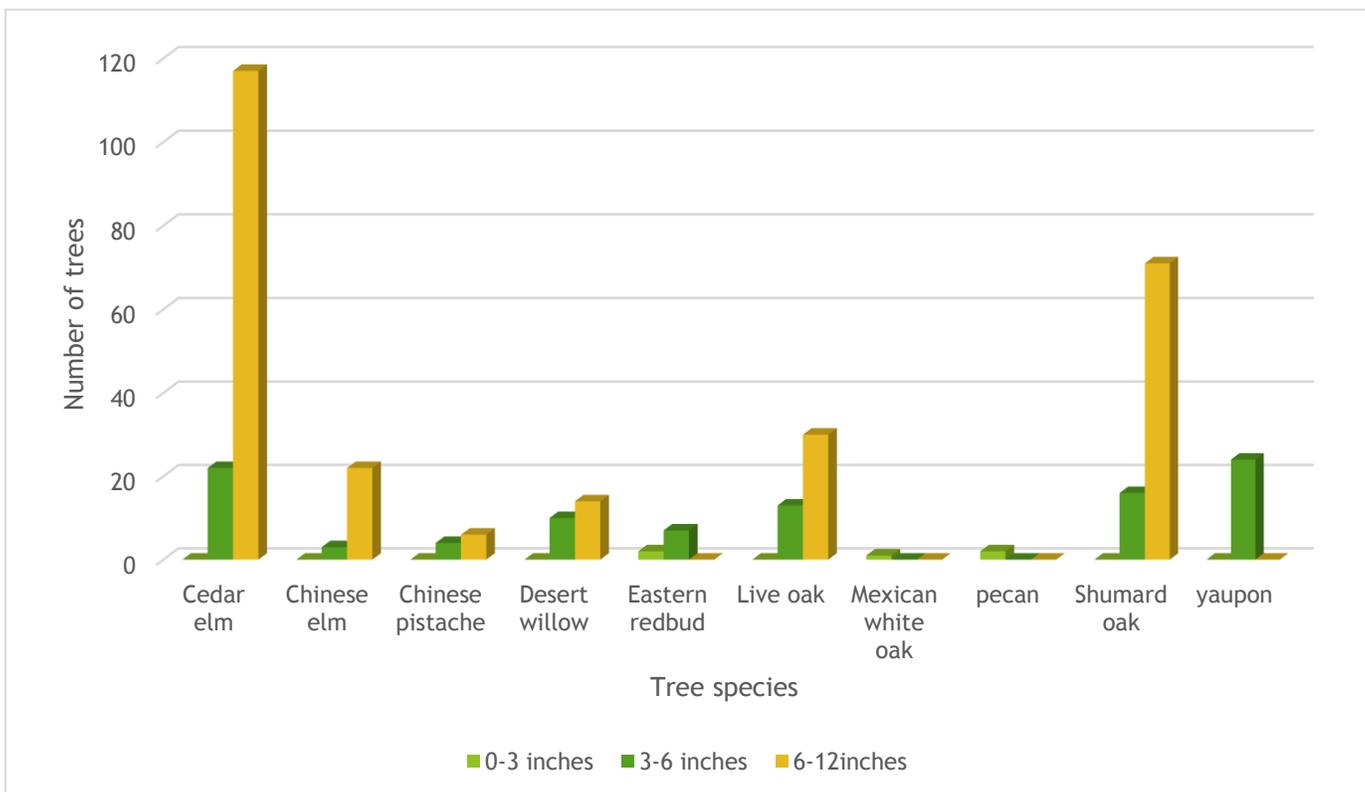


FIGURE 7: RELATIVE DIAMETER DISTRIBUTION OF ALL SPECIES PLANTED AT UNT DALLAS

THE VALUE OF UNIVERSITY OF NORTH TEXAS AT DALLAS URBAN FOREST

The benefits and numbers listed in this sections henceforth are from the i-Tree Eco assessment. For these observations, the entire 264 acres of UNT Dallas' campus was used in combination with the planted trees.

CARBON SEQUESTRATION AND STORAGE

Trees operate as a sink for carbon dioxide through fixing carbon during photosynthesis and storing it as biomass (Nowak, 2013). See Appendix V.

- **The gross sequestration of trees on the UNT Dallas campus is 901,900 pounds of carbon per year worth an annual value of \$60,000**

Carbon storage is a one-time value which represents the amount of carbon that is being stored collectively at the time of the inventory.

- **The trees are currently storing roughly 11,662,000 pounds (5,831 tons) of carbon worth \$775,808**



ENERGY SAVINGS

Trees can save energy by shading buildings, blocking winter winds and evaporative cooling. Trees are most efficient as energy savers, when they are planted along the east and west walls of the structure (Heisler, 1986). See Appendix IV for more information on Ecosystem Service Annual Benefits and Values

- **Trees on the UNT Dallas campus reduce energy related costs by an estimated \$3,510 annually.**

Heisler, Gordon. 1986. "Energy Savings With Trees," Journal of Arboriculture, 12(5), pp. 113-125.

Nowak, D.J., Greenfield, E.J., Hoehn, R.E., Lapoint, E. 2013. "Carbon storage and sequestration by trees in urban and community areas of the United States," Environmental Pollution, 178 (1) pp. 229-236.

ANNUAL RAINFALL INTERCEPTION

Trees help reduce storm water runoff by capturing and storing rainfall on leaves and branches which slows the infiltration rate of the water into the soil.

- It is estimated that the trees on the UNT Dallas property mitigate 3.5 million gallons of storm water each year, resulting in an annual savings of \$31,429.

This value is based on monthly storm water management fees that are assessed for moving, storing, and cleaning storm water.

AESTHETICS

Trees provide a plethora of aesthetic, social, economic and health benefits. One of the most common reasons for planting trees is for aesthetic purposes. Trees add beauty to an area by adding color, screening unsightly views as well as softening the man-made background. The calming effect of trees can greatly reduce workplace stress levels and fatigue as well as calm traffic (ISA, 2011).

“Benefits of Trees.” *International Society of Arboriculture*, 2011,
http://www.treesaregood.com/treecare/resources/benefits_trees.pdf



STRUCTURAL AND FUNCTIONAL VALUE

In addition to the environmental value, trees in an urban environment also possess structural/replacement value. The structural value of a tree is based on the estimated replacement costs of trees of the same size, species, condition and location. This value for a city or specific location such as UNT Dallas will vary based upon the total number of trees, the location of trees, species, diameter distribution and tree condition (Nowak, 2002). These values will not be consistent over time; they will vary with changes in the number of trees, tree size and tree health. Because of this, over time if the trees are properly managed, and continue to grow, the structural and functional value will increase.

The overall value of trees can also decrease over time, especially if there is an overall decline in tree health. Ensuring proper tree management is essential to maximizing the values of trees and the urban forest.

The following values represent the one-time structural values of the entire tree population on the 264 acres UNT Dallas campus, and the annual functional benefits which are provided while the tree is actively growing:

STRUCTURAL VALUES

- **Replacement value: \$53.4 million**
- **Carbon Storage: \$775,808**

ANNUAL FUNCTIONAL VALUES

- **Carbon Sequestration: \$60,000**
- **Energy Savings: \$3,510**
- **Storm water Mitigation: \$31,000**

D. Nowak, D. Crane, J. Dwyer. 2002. "Compensatory Value of Urban Trees in the United States", Journal of Arboriculture, 28(4), pp. 194-199.



OBSERVATIONS AND RECOMMENDATIONS

The University of North Texas at Dallas' urban forest provides many benefits to students and faculty as well as creates a sense of community while promoting an environment of learning. An increase in the understanding of the benefits the trees provide and their associated economic values can facilitate more precise and better planning and management of the landscape services.

Even though 70% of UNT Dallas' tree canopy is at risk, over 50% of the native trees on the entire property are Eastern Red Cedar. Eastern Red Cedars are native to this part of Dallas County and are extremely beneficial for wildlife, however, on the UNT Dallas campus they have become invasive and can consume large amounts of water. UNT Dallas has the unique opportunity to create a campus that is not only beautiful, but resilient, while increasing the quality of life for students and faculty.

Leaders must be cautious of which trees they choose to plant. With over 70% of the canopy consisting of three species; and with two of them in the same family, diversifying species selection in future planting initiatives is highly recommended to enhance the quality and resiliency of the campus tree population.

The following are observations and recommendations observed during the inventory process:

- Prioritizing which portions of the native landscape will be preserved is extremely important. Focusing on the biggest and best trees, trees along riparian areas, and trees that form natural buffers from roads, DART tracks, and other developed amenities should take priority.
- Developing and adopting guidelines and standards for future landscaping, tree care, and maintenance practices is highly recommended. Issues like canopy cover goals, soil volume requirements, and infrastructure needs should be addressed in this document.
- Green Infrastructure Best Management Practices need to be put into place for storm water management when planning for all future construction on campus.
- Careful monitoring of newly planted trees and tree impacted by construction is highly recommended. Fertilization and other arboriculture practices may be required to treat stressed trees. Also, careful inspection and where appropriate, rejection of poor quality nursery stock upon delivery is essential.
- Apply for and obtain Tree Campus USA certification.
- Diversifying species selection in future plantings to avoid canopy loss from a single pest or pathogen is recommended.
- Turf management practices around trees will continue to cause issues with tree health. Reducing turf within the drip line of tree and maintaining a rigorous mulching program will help in reducing these conflicts. Proper mulching; allowing a proper root flare at the base of the trunk, is essential to a rigorous mulching program. Along with reducing the turf around the drip line, the removal of irrigation tubes that are growing into the roots or trunk of trees is essential as well.
- Exposed root flares often get buried in high maintenance areas and steps should be taken to ensure that the root flares remain exposed and above ground.

- Protecting the Shumard oaks on the most southern end of the parking lots from sunscald is important to reduce the likelihood of pathogens entering the tree. *Sunscald can be easily prevented by wrapping the trunk with a white tree wrap in the late fall before the freezing temperatures occur, and removed the next spring after the freezing nights have passed. The use of tree wrap can also be avoided by shading the trunk and lower limbs through the planting of other shrubs or small trees on the southern side of these Shumard oaks.
- The removal of unnecessary tree stakes around the UNT Dallas campus will prevent damage from occurring on the trunk of the tree. Tree stakes that are left too long can inhibit the structural development of the tree because the trees need to be able to move freely in the wind.

**Wagner, K., Kuhns, M., "Sunscald Injury or Southwest Winter Injury on Deciduous Trees," Urban Forest Facts. Utah State University Cooperative Extension. http://extension.usu.edu/files/publications/factsheet/NR_FF_021pr.pdf accessed 15 Sept. 2016.*

This report provides the basis for better planning, protecting, managing, budgeting, and expanding the tree resource for the University of North Texas at Dallas campus. This assessment has provided the baseline for what is to come. Forest are not static, they change over time, and the need for updated data and planning will be ongoing. With strong leadership, sound research, and a clear vision this report will help UNT Dallas grow one of the most significant sectors of Dallas economically, educationally, and environmentally as they continue to set the tone for a cleaner, greener, cooler Dallas.

APPENDICES

APPENDIX I: I-TREE SPECIFICATIONS

i-Tree is a state of the art, peer reviewed tree evaluation tool which was created through the U.S. Forest Service and Davey Resource Group. i-Tree Eco v6.0.0 was used to determine the value of the trees ecosystem service benefits it provides on both an annual basis and the overall economic value for the one-time replacement cost. This software program does have its limitations and it is important to note that the i-tree portion of this inventory looked at the entire property UNT Dallas owned and not just the campus alone.

Peer reviewed, journal manuscripts were the foundation for this software program. It has been an industry wide known to be true program with merits from both the private and public institutions and professional organizations. Storm-water data was collected using local storm-water infrastructure from 20 municipalities to determine peak flow rates during rain events with communities with and without a significant tree canopy cover. Energy abatement values are from utility providers in the 20 main reference cities and were determined from power usage between treed and non-treed neighborhoods.

Other such non-tangible evidence of tree benefits was given from anecdotal studies of tree lined areas (hospitals, streets for crime prevention, schools, etc.) versus non-tree lined areas. Carbon storage and sequestration are approximate values determined by studies involving the amount of carbon which is interned within the cell walls of the plant material (mainly xylem).

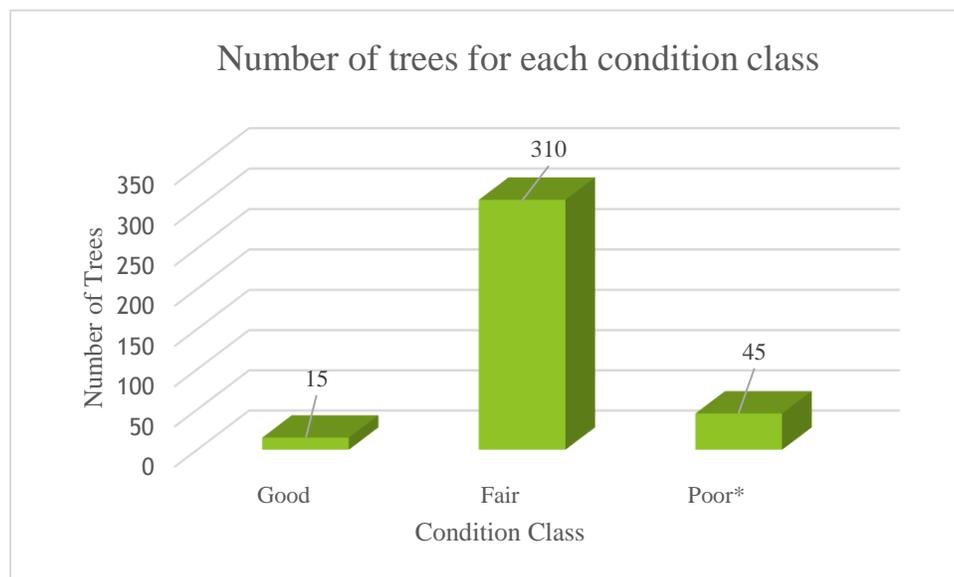
APPENDIX II: CONDITION RATING AND MAINTENANCE NEEDS OF UNT DALLAS CAMPUS TREES

CONDITION

The condition of a single tree can vary greatly over time. This inventory should be considered as a “snapshot” of each tree on the day that the tree was assessed. Information regarding the condition of the tree is important, but it is highly recommended that a system is put into place to guarantee the periodic assessment of the condition of all the trees on campus.

The rating system used for assessing tree health at UNT Dallas was reported as follows:

- **Good** – No apparent problems or issues; no dead limbs or leaves and the tree is growing extremely well with a well excised root flare in a good location with little to no scars, wounds or decay.
- **Fair** – Few apparent problems or issues; few dead limbs or twigs were present and leaves may have been slightly chlorotic or scorched/wilted. Root collar may be buried but few scars, wounds or decay present.
- **Poor** – Many problems and issues were present, including but not limited to wounds and decay; many scars, buried root collars and death or decline of large tree parts.
- **Dead** – Life processes have ceased and the tree is now in a state of high risk if not removed.



Number of trees in each condition class at the time of the inventory

**three of the trees marked as poor are removal trees*

MAINTENANCE RECOMMENDATIONS

On the campus of UNT Dallas, 325 of the 370 trees are in a fair to good condition, which is a very positive find. Because no individual tree is completely healthy and free of defects, these condition ratings are a good reflection of the overall condition of the trees on campus. Although there trees overall are in good condition, there are a total of three trees which were classified as priority one removals. Tree health can vary day to day as lightning strikes, collisions, and other objects are directly competing for the same space.

ROOT COLLAR EXCAVATION

The root collar is an important area of the tree; it is the interface between trunk and roots. In this area, the tissue grows about 1.5 times faster than the trunk. This is where the flare is created. It helps retain support and structure for the tree during wind events and aids in gas exchange for respiration. If buried, the tree could suffocate from gas interruptions or latent buds could be activated and circling, potentially girdling roots could be formed at the base; weakening the entire structure of the tree. To ensure long term survival measures should be taken to keep the root collar clear of excess soil, grass, or other obstacles. If the root collar is already buried an air spade can be used to remove the excess material without causing damage to the existing root system.

PRUNING

On the UNT Dallas campus there are a few different types of pruning that need to be done. The majority of prunes that need to be completed are structural prunes on small trees. Many of the defects currently present such as double leaders or co-dominant stems, can be corrected at an early age and should be done following the first growing season following the planting of the new tree. Clearance prunes were not a major issue on the campus, but there were a few trees which needed it. When there were no immediate primary maintenance needs and if there was a structural prune required, this is when the small tree (routine) or large tree (routine) prune was recommended.

OAK WILT TREATMENT

Oak wilt is a detrimental disease affecting live oaks and red oaks throughout Texas. The tree mortality stems from the spreading of the pathogen between trees through grafted root systems. Although Oak Wilt has not been identified at UNT Dallas, the fact that it is present at SMU and in Highland park, alongside with the fact that 36% of the trees planted at UNT Dallas are either Shumard oaks or live oaks, calls for careful consideration of how to best avoid spreading the disease. Pruning of live oaks and red oaks SHOULD NOT be performed from February to June. Pruning tools should be sterilized in between trees when pruning in an area

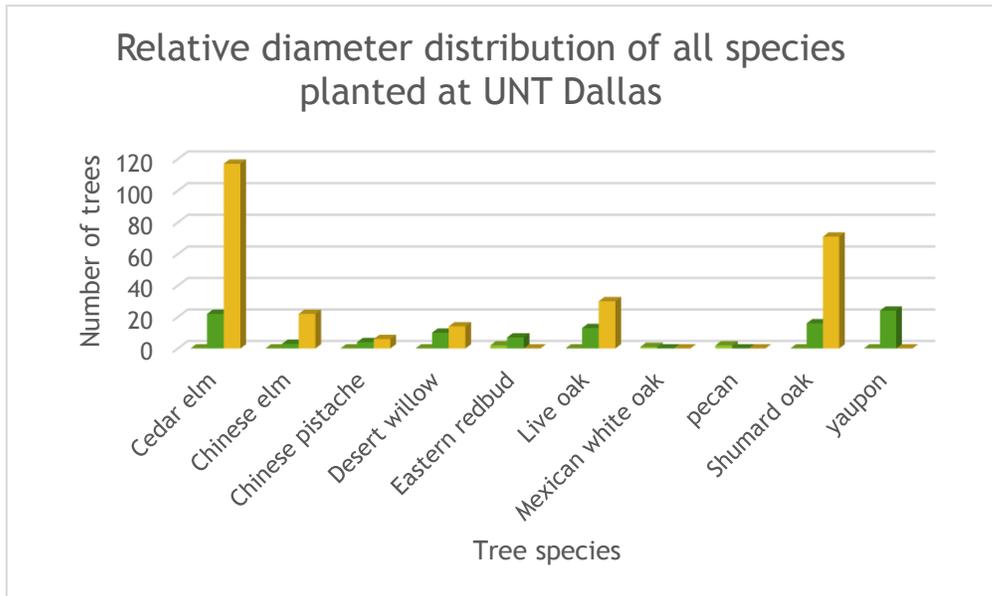
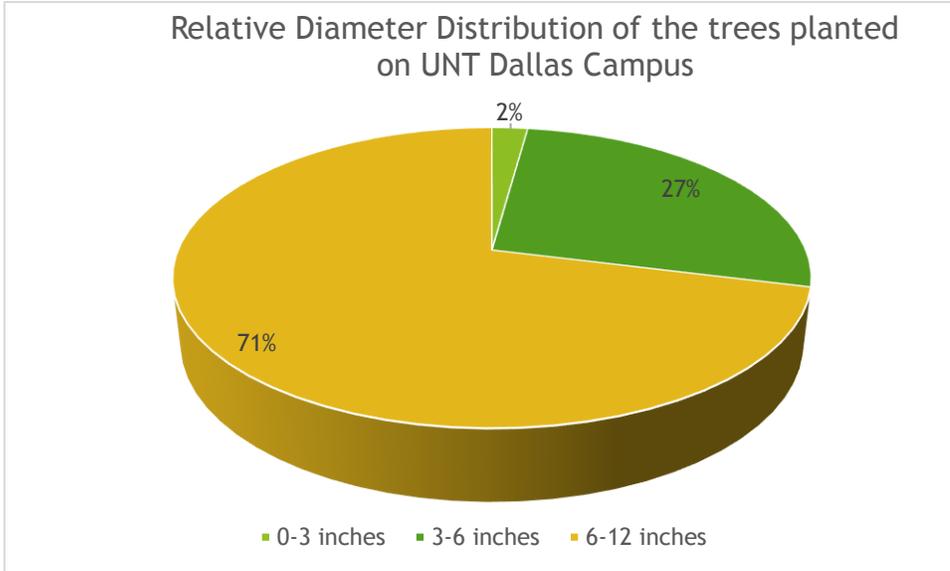
where oak wilt is known to occur. Pruning cuts and other wounds should be painted on Live oaks and Red oaks only to help limit the spread of the pathogen.

For more information about Oak Wilt please visit texasoakwilt.org.

REMOVE FOREIGN OBJECT

The removal of foreign objects refers to the removal of items that are not related to the assistance of the structure or growth of the trees. These foreign objects can inhibit the growth of a tree, grow into the bark, cause a wound as well as cause a potential opening for pathogens to enter.

APPENDIX III: DIAMETER DISTRIBUTION AND POPULATION SUMMARY OF ALL UNT DALLAS TREES



Population Summary of the Trees on the Campus of UNT Dallas

Species	DBH Class (in)		
	0-3	3--6	6--12
Cedar Elm	0	20	119
Shumard Oak	2	17	72
Live Oak	0	13	30
Chinese Elm	0	3	22
Desert Willow	1	10	14
Yaupon	0	24	0
Chinese Pistache	0	4	6
Eastern Redbud	2	7	0
Pecan	2	0	0
Mexican White Oak	1	0	0
Southern Red Oak	0	1	0
Campus Total	8	99	263

Population Summary of the Trees on the Entire Property owned by UNT Dallas (percent of species)

	DBH Class (in)								
	0 - 3	3 - 6	6 - 9	9.1 - 12	12 - 15	15 - 18	18 - 21	21 - 24	24.1 - 27
Species	%	%	%	%	%	%	%	%	%
Eastern redbud		100.00							
Green ash	60.00		20.00	20.00					
Honeylocust	50.00	50.00							
Eastern red cedar	15.00	30.00	25.00	15.00	10.00	2.50	2.50		
Osage orange				50.00					50.00
Callery pear				100.00					
Shumard oak		75.00	25.00						
Cedar elm	10.00	50.00	35.00			5.00			

UNT Dallas Campus

Species Distribution of all trees on campus

Species	Percent
Cedar Elm	37.57%
Shumard Oak	24.59%
Live oak	11.62%
Chinese Elm	6.76%
Desert Willow	6.76%
Yaupon	6.49%
Chinese Pistache	2.70%
Eastern Redbud	2.43%
Pecan	0.54%
Mexican White Oak	0.27%
Southern Red Oak	0.27%
Total	100.00%

Species Distribution of trees on the entire property owned by UNT Dallas

Species	Percent
Eastern red cedar	51.3 %
Cedar elm	25.6 %
Green ash	6.4 %
Shumard oak	5.1 %
Eastern redbud	3.8 %
Callery pear	2.6 %
Osage orange	2.6 %
Honeylocust	2.6 %
Total	100%

APPENDIX IV: ANNUAL ECOSYSTEM SERVICE BENEFITS FROM ALL TREES ON PROPERTY OF UNT DALLAS CAMPUS

Average Annual Benefits of All Trees (\$/species)

Species	Carbon Storage		Gross Carbon Sequestration		Avoided Runoff		Pollution Removal		Structural Value
	Ton	\$	Ton/Yr	\$/yr	ft3/yr	\$/yr	Ton/Yr	\$/yr	\$
Eastern redbud	37.92	5,045.64	13.67	1,819.38	5,363.13	358.50	0.15	341.24	736,202.09
Green ash	149.11	19,838.82	16.71	2,223.23	34,934.42	2,335.22	0.98	2,222.75	2,029,799.01
Honeylocust	50.88	6,769.06	9.36	1,245.20	1,363.93	91.17	0.04	86.78	167,080.27
Eastern red cedar	2,698.68	359,053.49	160.81	21,396.06	299,084.81	19,992.58	8.39	19,029.64	23,592,718.70
Osage orange	1,439.44	191,514.20	68.88	9,164.52	13,498.22	902.30	0.38	858.84	814,8817.36
Callery pear	229.66	30,556.28	17.52	2,331.35	15,026.93	1,004.49	0.42	956.11	2,834,093.48
Shumard oak	188.30	25,052.47	38.95	5,181.73	16,811.20	1,123.76	0.47	1,069.63	3,557,823.17
Cedar elm	1,037.06	137,978.82	125.04	16,636.36	84,092.91	5,621.26	2.36	5,350.52	12,410,828.64
Total	5,831.05	775,808.79	450.95	59,997.82	470,175.55	31,429.28	13.18	29,915.51	53,477,362.71

Total Annual Benefits and Gross Benefits for all Trees

Benefits	Total \$ (USD)	\$ (USD)/tree
Energy	3,509	0.05
Gross carbon sequestration	59,998	0.89
Pollution removal	29,916	0.44
Avoided runoff	31,429	0.46
Total Benefits	124,852	1.84

Energy Mitigation Benefits for all Trees

Amounts			
Type	Heating	Cooling	Total
MBTU	-11.45	n/a	-11.45
MWH	-0.13	32.68	32.56
Carbon Avoided (ton)	-0.21	7.17	6.96

Energy Values \$			
Type	Heating	Cooling	Total
MBTU	-124	n/a	-124
MWH	-14	3647	3633
Carbon Avoided	-28	954	927

Carbon avoided value is based on \$133.05 per ton.

Energy saving value is calculated based on the prices of \$111.59 per MWH and \$10.81 per MBTU.

Trees less than 20ft/6m tall and further than 60ft/18m away are not used to calculate energy benefits.

Annual Runoff Benefits of All Trees by Species on the Entire Property Owned by UNT Dallas

Species Name	Number of Trees	Leaf Area (ac)	Avoided Runoff (ft³/yr)	Avoided Runoff Value (\$/yr)
Eastern red cedar	34,705.00	1,079.10	299,084.81	19,992.58
Cedar elm	17,352.00	303.41	84,092.91	5,621.26
Green ash	4,338.00	126.04	34,934.42	2,335.22
Shumard oak	3,470.00	60.65	16,811.20	1,123.76
Callery pear	1,735.00	54.22	15,026.93	1,004.49
Osage orange	1,735.00	48.70	13,498.22	902.30
Eastern redbud	2,603.00	19.35	5,363.13	358.50
Honeylocust	1,735.00	4.92	1,363.93	91.17
Total	67,674.00	1,696.39	470,175.55	31,429.28

Avoided runoff value is calculated by the price \$0.067/ft³

APPENDIX V: CARBON STORAGE AND SEQUESTRATION VALUES

Annual CO₂ Sequestration of all Trees by Species

Species	Net Carbon Sequestration (ton/yr)	CO ₂ Equivalent (ton/yr)
Eastern redbud	13.48	49.44
Green ash	16.09	58.99
Honeylocust	9.27	33.98
Eastern red cedar	116.73	428.04
Osage orange	50.44	184.95
Callery pear	16.60	60.88
Shumard oak	38.10	139.71
Cedar elm	120.95	443.53
Total	381.65	1,399.52

Stored CO₂ Amounts of All Trees by Species

Species	Carbon Storage (ton)	Carbon Storage (%)	CO ₂ Equivalent (ton)
Eastern redbud	37.90	0.7 %	139.10
Green ash	149.10	2.6 %	546.80
Honeylocust	50.90	0.9 %	186.60
Eastern red cedar	2,698.70	46.3 %	9,896.10
Osage orange	1,439.40	24.7 %	5,278.40
Callery pear	229.70	3.9 %	842.20
Shumard oak	188.30	3.2 %	690.50
Cedar elm	1,037.10	17.8 %	3,802.90
Total	5,831.00	100%	21,382.50

ABOUT TEXAS TREES FOUNDATION

The Texas Trees Foundation, formerly the Dallas Parks Foundation, was established as a 501 (c)(3) organization in 1982 as a resource to support the Dallas parks system. In 1998, the Foundation merged with Treescape Dallas, Inc., a project that had been funded by the Dallas Junior League and the Central Dallas Association. The Texas Trees Foundation was then known as the Dallas Trees and Parks Foundation. In 2003, the Foundation was renamed the Texas Trees Foundation to expand the area of focus from Dallas to the North Texas region to better reflect its mission. The Texas Trees Foundation has a rich history and is positioned to build on the traditions established by its founders and nurtured by the generous support of individuals, foundations, corporations and, agencies throughout Texas.

MISSION

The Mission of the Texas Trees Foundation is (i) to preserve, beautify and expand parks and other public natural green spaces, and (ii) to beautify our public streets, boulevards and rights-of-way by planting trees and encouraging others to do the same through educational programs that focus on the importance of building and protecting the “urban forest” today as a legacy for generations to come. The Foundation will share its vision on a national level, but will focus its efforts and develop loyalties among communities in the North Central Texas area.

VISION

The Texas Trees Foundation has a vision for our community. It is a community comprised of beautiful, well maintained parks, shady tree-lined streets and boulevards, hiking, biking and nature trails, and other outdoor amenities which combine to form a living and working environment that enhances the economic value of its commercial areas and its neighborhoods, and nurtures the health, safety and quality of life of all its citizens; a community in which its citizens actively participate in building and sustaining its “urban forest.” The Foundation will serve as a catalyst in creating such a community.

TEXAS TREES FOUNDATION
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Janette Monear, President/CEO

Janette K. Monear is the President/CEO of Texas Trees Foundation in Dallas, Texas. The Texas Trees Foundation is a private non-profit dedicated to “Greening North Central Texas.” Under Monear’s leadership, the Foundation maintains the TXU Energy Urban Tree Farm and Education Center and supports tree-planting projects and education outreach for municipalities, schools, utilities, and builders/developers. With the national agenda for environmental action catalyzing around global climate change, air and water quality, and energy conservation, Texas Trees Foundation has created a national model, *The Roadmap to Tree Planting in the Dallas*, by identifying and prioritizing planting sites through the use of geographical information systems (GIS). The emphasis for urban forestry through community development provides a platform for Ms. Monear to create partnerships that support programs and projects that improves the quality of life in communities.

Prior to her work with the Texas Trees Foundation, Ms. Monear was the Director of Urban & Community Forestry for the Tree Trust in Minnesota, where she developed the *Time for Trees* outdoor learning program, the *Trade-a-Tree* program with utilities, and a grant program that helps communities replace hazardous trees under power lines with small-stature trees. She worked closely with the MN Department of Natural Resources, local government planners, foresters, and soil and water conservation district professionals to develop comprehensive programs for protecting and managing community forest resources for maximum benefit for the environment -- especially in rapidly growing communities. She also developed TreeOrd, an interactive CD-ROM for local governments to write tree ordinances, a Community Tree Planting Manual, Environmental Service Learning Manual, and the new Open Spaces-Clean Water guidebook. Her recent award winning guidebook, *City Trees Sustainability Guidelines and Best Practices*, has positioned trees as a capital asset and part of a community’s infrastructure. Ms. Monear also co-produced the international award winning Public Television documentary, *Spirit of the Trees*.

Ms. Monear began work in community forestry for the University of Minnesota as an Anoka County Extension Specialist for Oak Wilt where she coordinated a statewide effort for Oak Wilt suppression to preserve trees and promote research. She served on the Board of Trustees for TreeLink, an international website for urban forestry, is active with the National Alliance for Community Trees, Regional Tech Transfer Committee of the USDA Forest Service, Dallas Urban Forestry Advisory Committee, and served on the Arboretum Advisory Council for Saint John’s University, Collegeville, Minnesota. Monear is a frequent speaker and panelist at regional and national environmental and land-development conferences. She is recognized nationally for her

more than 30 years of experience in urban forestry, program development and project implementation. She has received numerous awards which include the President's Award for the Minnesota Shade Tree Advisory Council (MNSTAC), Chevrolet Geo Award of Excellence, Minnesota Shade Tree Advisory Committee Innovation Award for the City Trees Sustainability Guidelines & Best Practices Guidebook, and the Distinguished Service Award from the Minnesota Society of Arboriculture.

Matt Grubisich, Operations Director/Urban Forester

Matt Grubisich received his Bachelor of Science in Urban Forestry and Forest Management from Iowa State University and has been working in the Urban Forestry field for over 13 years in the DFW area. Matt joined the Texas Trees Foundation staff as the Operations Director/Urban Forester in September 2010 after working 2 years as a private consulting arborist/urban forester specializing in assisting communities, developers, landscaping companies and others with Urban Forestry related issues. Prior to consulting, he served eight years with the Texas Forest Service as the Regional Urban Forester serving the Dallas and surrounding areas.

Matt is a Certified Arborist with the International Society of Arboriculture (ISA) and specializes in GIS mapping, technology transfer, and eco-system analysis.

His recent work in Arlington, McKinney, Mesquite, and in Dallas has produced several tools advancing Urban Forestry in those communities. Matt has hands-on experience with GIS based eco-system studies and urban forestry development with federal, state, and local government agencies, utilities, private firms, non-profits and universities.

Matt has served in a leadership position on several boards and commissions including President of the Trinity Blacklands Urban Forestry Council, Chair of the Dallas Chapter of the Society of American Foresters, founding member of the Dallas Urban Forestry Advisory Committee and two terms on the Rowlett Parks and Recreation Board. He is a frequent speaker at national & state conferences and workshops related to urban forestry and green infrastructure management.

Gordon Tyler Wright, M.S., Urban & Community Forester

G. Tyler Wright, a native of Lyndhurst, Virginia, earned his Bachelor of Science in Forestry degree while attending West Virginia University (Morgantown, WV) and has a Master of Science in Forestry from Virginia Polytechnic Institute and State University, (Blacksburg, VA). Tyler's five successful internships with the F. A. Bartlett Tree Expert Company Research

Laboratory and Arboretum, earned him a position as a Plant Health Care Technician. Tyler also worked for Davey Resource Group as a Municipal Inventory Arborist, capturing street tree data in Spokane and Seattle, WA. In 2013, Tyler was hired by the Texas Trees Foundation as an Urban and Community Forester. His duties include research/technology, education outreach, nursery management/volunteer and internship coordination, urban forest project management and he provides technical assistance for urban forestry consulting to municipalities, universities, corporations and homeowners. Tyler is a Certified Arborist and has earned several awards from Gamma Sigma Delta, WVU Division of Forestry and Natural Resources, VPI& SU Forestry Student Graduate Association, and VPI&SU Forestry Graduate Symposium. He is a member of the Dallas Urban Forestry Advisory Committee, Trinity Blacklands Urban Forestry Council and the International Society of Arboriculture. Tyler is an articulate speaker and has shown merit in working with different organizations and industry professionals.

Taylor Guynes, Urban Forestry Project Manager

Taylor Guynes, a native of Plano, Texas, earned his Bachelor of Science in Forestry at Texas A&M University. Before attending Texas A&M, Taylor volunteered 264 hours at the Texas Trees Foundation tree farm operation, located on the campus of Richland College. In the summer of 2014, Taylor completed an internship with Texas Trees Foundation and helped gather data for the State of the Dallas Urban Forest Report. In the summer of 2015, he also completed an internship with the Texas A&M Forest Service. In June, 2016, Taylor was hired by the Texas Trees Foundation as an Urban Forestry Project Manager. His duties include urban forestry project management, education outreach, as well as nursery management and volunteer coordination.