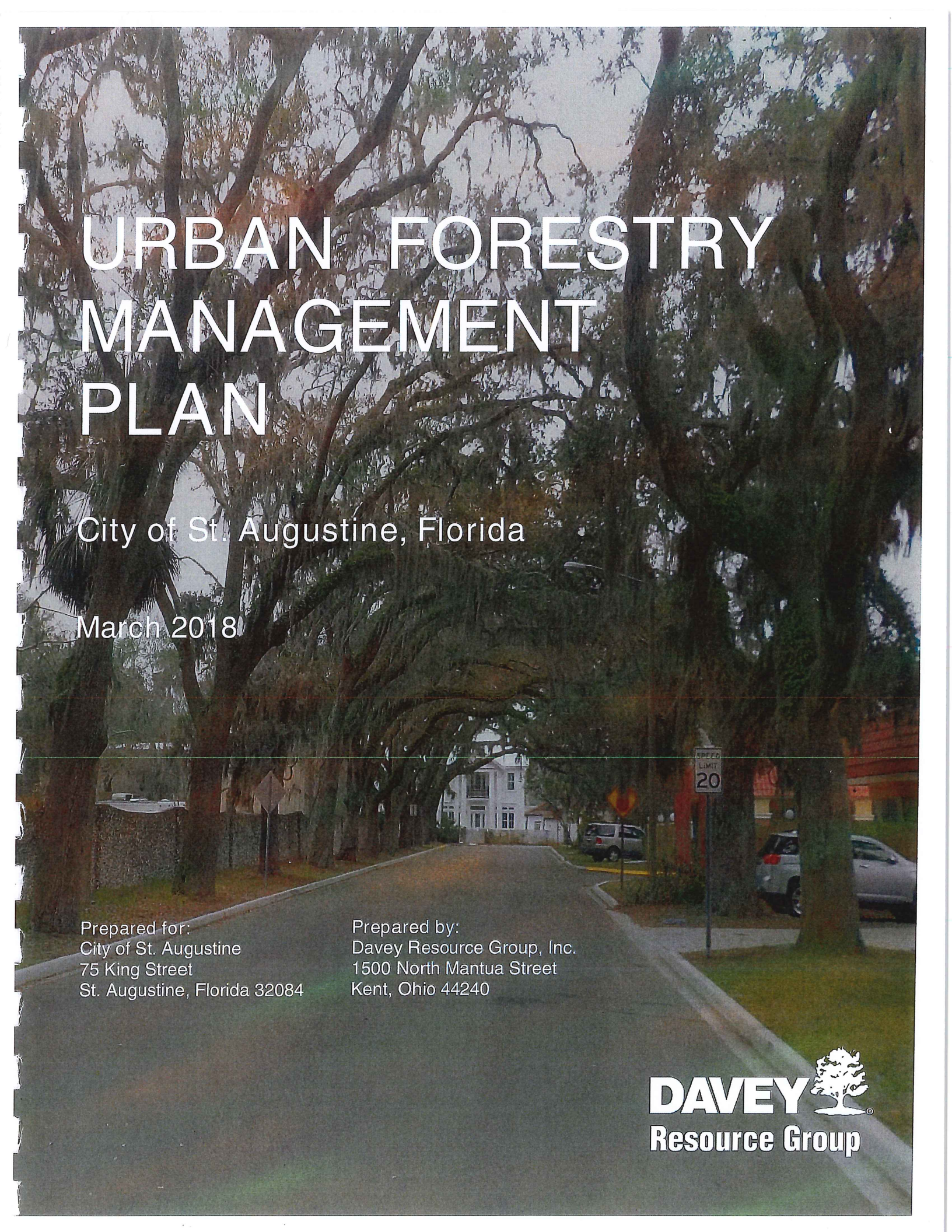

URBAN FORESTRY MANAGEMENT PLAN

City of St. Augustine, Florida

March 2018

Prepared for:
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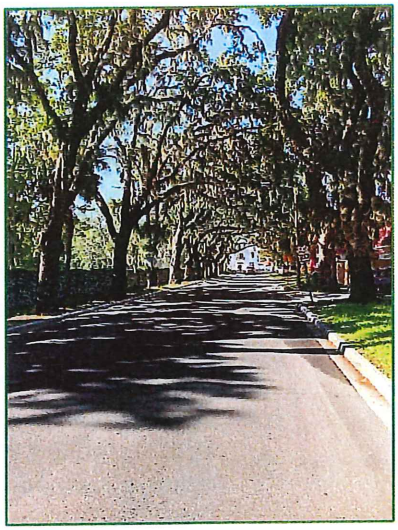


St. Augustine has a vision that its urban forest is safe, efficient to maintain, complements its development goals, delivers equitable benefits, and enhances the historic character of the city. To accomplish goals and objectives to realize this vision, a comprehensive tree management plan is required. This plan was developed to assist St. Augustine in better understanding its urban forest's composition, structure, and tree maintenance needs as well as plan for both short-term and long-term resource allocation and develop risk management strategies.

The plan was accomplished by completing these tasks:

- Conduct a tree and planting site inventory
- Estimate the citywide canopy cover
- Calculate tree benefits
- Develop a proactive tree maintenance and planting program
- Obtain public and stakeholder input
- Make data-driven, sustainable urban forest management recommendations
- Present a multi-year budget

A brief summary of the data acquired, stakeholder input, and list of recommendations follows.

City of St. Augustine Tree Inventory

The tree inventory is an important planning tool that should help the City of St. Augustine establish a systematic program for tree care and determine budget, staff, and equipment needs. Implementation of the maintenance recommendations will improve public safety and help guide future management decisions. When properly maintained, trees return economic, environmental, and social value to the community. These benefits greatly outweigh the time and money invested in planting, pruning, protection, and removal. Davey Resource Group, Inc. "DRG" completed a tree inventory for St. Augustine in July 2017. All trees and planting sites along the city's public street rights-of-way (ROW) were inventoried. The inventory was only completed on the mainland; public trees on the island were not included. The following brief statistical summary of the street tree population reflects genus and species composition, condition, primary maintenance recommendations, and risk ratings:

- A total of 2,968 sites were inventoried, including 2,928 trees and 40 planting sites.
- Generally, species diversity in St. Augustine's urban forest is low, since palm and oak species represent a combined 71% of the population. The inventory found 57 species representing 42 genera, with palm trees comprising 51% of the tree population; oak, 20%; crapemyrtle, 6%; cedar, 4%; elm, 3%; holly, 2%; and all other genera, 14%.
- Just over one-third of non-palm trees are in fair or better condition. Conditions include: 521 Good trees (18%); 566 Fair trees (19%); 346 Poor trees (12%), and 16 Dead trees (1%); palm tree conditions were not recorded.

- Since the majority of public trees are in fair or better condition, required maintenance is considered routine. Recommended primary maintenance needs include: 871 Tree Cleans (29%); 448 Young Tree Trains (15%); 122 Removals (4%); and 40 Plant Trees (1%). Primary maintenance needs for palms were not recorded.
- Almost one-half of non-palm trees inventoried are low risk. Risk ratings include: 1,383 Low Risk trees (46%); 75 Moderate Risk trees (3%); and 1 High Risk tree (< 1%). Risk ratings for palm species were not recorded.

St. Augustine's 2017 Urban Tree Canopy Analysis

The urban tree canopy (UTC) is determined by classifying the land cover within the entire city boundaries; this include both public and private properties. It was determined that St. Augustine's current estimated UTC is 24%. While this UTC percentage is lower than other Florida cities and is below recommended levels for the eastern United States, St. Augustine has a low impervious surface percentage, indicating there is land that could sustain additional trees. Being a coastal city with significant inland waterways also explains the lower UTC percentage. If the open water land cover is removed from consideration, then St. Augustine's UTC is 35%.

St. Augustine Land Cover Types

Land Cover Classification	i-Tree Canopy Assessment
Tree Canopy	24%
Impervious Surfaces	15%
Grass & Low Vegetation	20%
Bare Soils	9%
Open Water	32%

The land cover classification was performed using the U.S. Forest Service's i-Tree Canopy model which only provides an estimate. A UTC and land cover analysis using current aerial photographs would result in more precise data.

Tree Benefit Analysis

Trees provide significant co-benefits to the City of St. Augustine. Every year, and simultaneously, trees give the city and citizens the benefits of air and water quality improvement, stormwater management, energy use reduction, and enhanced property values and aesthetics, among many others.

On an annual basis, St. Augustine's citywide tree canopy provides almost $900,000 in quantifiable ecosystem benefits related to air pollution abatement and carbon storage. If the canopy was expanded just 3% more, the benefits would increase 10% more.

On an annual basis, the public trees contribute over $178,000 in benefits. The largest benefit categories are stormwater, energy reduction, and property values.

The ecosystem benefits of St. Augustine's citywide tree canopy and that of its public trees were calculated using the i-Tree Canopy model and the i-Tree Streets model.

Citizen and Stakeholder Input

From a public roundtable, stakeholder survey, and Commission meetings, it was discovered that the citizens of St. Augustine care about their trees and value the benefits provided by them. 93% of respondents believed that trees define the character of St. Augustine, improve the quality of life, and enhance tourism and city attractions.

Input and opinions on the city's urban forest management program were also obtained. The top four priorities citizens said they would like the city to address are: 1) historic tree preservation; 2) more tree planting; 3) more/better tree maintenance; and 4) better communication with citizens about the urban forest and activities of the program.

Urban Forest Management Recommendations

Based on the analysis of the inventory and UTC data, with stakeholder and city staff input, and applying arboricultural industry standards and best management practices, the St. Augustine Urban Forestry Management Plan presents recommendations in major action steps and outlines programs and procedures for achieving success for small and large tasks in both the short and long terms.

Prioritized Compilation of Recommendations with
Estimated Costs to Improve Urban Forestry Management and Service Delivery

Action Step	Recommendation	Timeframe	Fiscal Impact	Priority
Perform Priority and Proactive Maintenance - General	Remove designated trees and inspect poor condition trees	Short term (1–5 years)	$48,000 (estimated total for 5 years)	High
	Update the inventory database regularly	Short term (1–5 years)	$0 (staff time)	High
Perform Priority and Proactive Maintenance – Pruning	Perform tree pruning on trees identified as Extreme, High, and Moderate Risk	Short term (1–5 years)	$10,000 (estimated total for 5 years)	High
	Implement a 3-year young tree maintenance cycle	Short term (1–5 years)	$15,000 (estimated total for 5 years)	High
	Establish a 5-year routine pruning cycle	Short term (1–5 years)	$97,000 (estimated total for 5 years)	High
Perform Priority and Proactive Maintenance – 5-Year Cycle and Budget	Allocate at least $38,000 annually for proactive tree care and planting	Short term (1–5 years)	$38,000/year	High

Action Step	Recommendation	Timeframe	Fiscal Impact	Priority
Practice Purposeful Planting	Avoid planting additional live oaks and palms, favoring other high-benefit species	Mid-term (5–10 years)	NA	Medium
	Create a citywide master tree planting plan	Long term (10+ years)	$0 (staff time) $12,000 (consultant)	Medium
	Consider innovative solutions to restricted growing areas for large trees	Mid-term (5–10 years)	$0 (staff time)	High
	Select salt-tolerant species when possible	Mid-term (5–10 years)	NA	High
Set a UTC Goal	Set a UTC goal with stakeholder input	Mid-term (5–10 years)	$0 (staff time)	Medium
Improve Ordinances and Policies	Incorporate urban forest data and goals into the Comprehensive Plan	Short term (1–5 years)	$0 (staff time)	Medium
	Update Chapter 25 Trees and Landscaping	Mid-term (5–10 years)	$0 (staff time) $12,000 (consultant)	Medium
	Improve inter-departmental policies and communication	Mid-term (5–10 years)	$0 (staff time)	Low
Identify New or Supplemental Funding	Consider funding options	Mid-term (5–10 years)	$0 (staff time)	Medium
Perform Public Engagement and Build Partnerships	Develop compelling messages	Mid-term (5–10 years)	$0 (staff time) $5,000– $10,000 (consultant)	Medium
	Develop an outreach plan	Mid-term (5–10 years)	$0 (staff time) $5,000–$10,000 (consultant)	Medium
	Create strong community partnerships	Long term (10+ years)	$0 (staff time)	Medium
	Maximize the city's communication resources and talents	Mid-term (5–10 years)	$0 (staff time)	Low
	Create a Tree Stewards program	Long term (10+ years)	$0 (staff time)	Low

Action Step	Recommendation	Timeframe	Fiscal Impact	Priority
Increase and Train Urban Forestry Staff	Add a field arborist position	Mid-term (5–10 years)	$45,000 annually	Medium
	Provide training for staff	Short term (1–5 years)	$1,000–$2,000 annually (dues, training, and certification fees)	Medium
Regularly Update and Monitor the Plan, UTC, and Inventory	Update urban forest data and planning documents	Mid-term (5–10 years)	$0 (staff time) $15,000 (UTC mapping/analysis by consultant)	High
	Monitor the Plan's success	Mid-term (5–10 years)	$0 (staff time)	High

INTRODUCTION

Statement of Purpose

The trees in St. Augustine are important components of the livability, sustainability, and ambiance of the city. The city's urban forest provides numerous benefits that are both tangible and intangible. St. Augustine is seeking solutions to maintaining the historic character of the city while simultaneously dealing with modern and costly urban challenges like stormwater management, urban heat island effects, public health issues, and economic development. St. Augustine recognizes that trees help define the character of the city and can be low-cost, high-impact infrastructure that provides solutions to many urban challenges. However, St. Augustine does not currently have a community-wide tree management plan in place to sustain this important infrastructure.

Given the value of the urban forest, the City of St. Augustine has taken the proactive step of creating a comprehensive, long-term Urban Forestry Management Plan. The Urban Forestry Management Plan is intended to provide strategies, goals, policies, standards, and actions to protect, enhance, expand, and preserve public trees and the tree canopy for the benefit of the community. The Plan intends to help coordinate and improve the city's tree management in an equitable, economic, and sustainable manner. Moreover, the Plan will be a valuable strategic planning tool that can support other municipal plans and projects.

This Plan was systematically developed by a comprehensive review of existing city ordinances, specifications and standards, other urban forest plans, and information, through interviews with key city staff and leaders, using public participation input, analyzing inventory data and field observations, and by applying national arboricultural standards and best management practices. This is a holistic, customized Urban Forestry Management Plan for the City of St. Augustine based on local conditions, resources, and priorities.

Vision

The Urban Forestry Management Plan takes its vision from the city's desire to maintain a high quality of life by focusing on actions to increase the benefits and values of trees, reduce risk, and improve the responsible management of St. Augustine's urban forest. The Plan envisions these conditions for the future of the city's urban forest:

Urban Forestry Management Plan Vision Statement

- *The City of St. Augustine will have a safe, healthy, and diverse tree canopy by promoting tree preservation and planting within the city.*
- *With the use of professional urban forestry leadership and staff, proper maintenance and planting techniques, more efficient management of city resources, and public education and support, the city's future urban forest will be viewed as an important community asset.*
- *The urban forest will uniquely define the city's character and be a major factor in the continued growth and livability of St. Augustine.*

This plan is organized in four chapters that describe the characteristics of the urban forest, outline the value and services provided by trees in St. Augustine, assess the sustainability of the city's existing urban forest, and put forth 24 recommendations for action on how to achieve that vision.

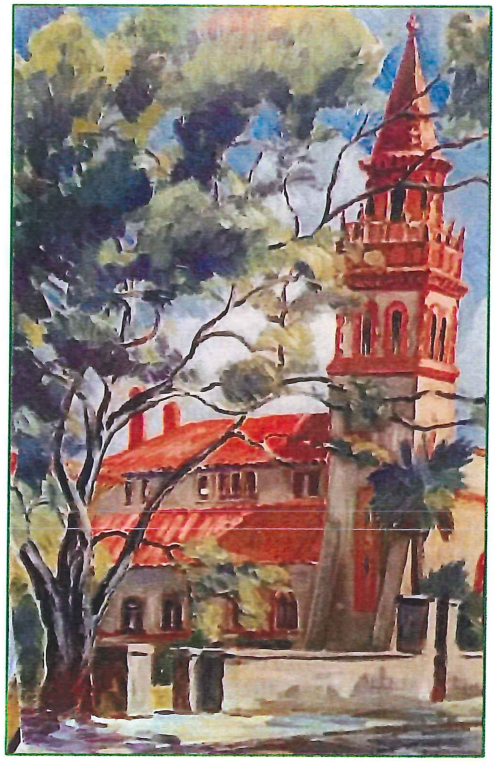
The Process. This plan is the result of a series of interview, research, and analyses tasks centered around the following questions and topics:

What do we have now?

- How much tree canopy does St. Augustine have?
- Where is the tree canopy?
- What is the condition of the current urban forest?
- What are the strengths of our current urban forest, and what challenges are we facing in the coming years?

What do we want in the future?

- What is St. Augustine's vision for the future urban forest?



How do we get there?

- What do we need to reach our future goals?
- What steps will get us there?
- What resources will be needed?
- Where do we start?

How will we measure success?

- What benchmarks should we use to measure success over the coming years?
- How often should we take stock of our progress and re-evaluate?

The Data Sources. To help answer these questions and support the recommendations, urban forest data were analyzed and many sources of information were used and referenced, and included:

- An urban tree canopy (UTC) assessment;
- Examination of the current street tree inventory data;
- Interviews and meetings with city staff to examine the city's approach to management of the public trees and discuss future goals;
- Review of previous inventory data and reports, existing plans and documents, and the city's code of ordinances;
- Informal public opinion survey; and
- Best practices sources such as American Public Works Association's Guidance Statement on Quality Management of the Urban Forest and current arboricultural industry standards and best management practices.

The following plan sections present the findings of the analyses and recommend the next steps in creating a sustainable urban forest for the current and future citizens of St. Augustine.

STRENGTHS AND CHALLENGES

As part of the answer to the question "What do we have now?", St. Augustine's urban forest management program and the tree resource itself have many strengths, but also a number of challenges that either affect the safety and quality of the urban forest or the staff's ability to manage the program proactively and efficiently.

Strengths

Current Canopy Provides Significant Benefits. Over 24% of St. Augustine is covered with trees (on both private and public lands). Annually, the urban tree canopy provides over $900,000 in a variety of ecosystem benefits and greatly enhances the livability of the city.

St. Augustine's street, park, and other public property tree population contains over 2,900 inventoried trees and contributes over $177,900 annually in benefits. The species diversity and overall condition of the publicly managed trees are both good.

Trees and Forest Protection is in Place. The city has several tree ordinances, development regulations, and subsections of ordinances that address authority for public trees, protection of trees, guidelines and standards for landscaping, and tree preservation during land development. While some chapters and sections could be updated and improved to advance the professional and comprehensive management of the urban forest, the basic provisions for tree protection and management are codified.

Public Forest is Managed by Professional Staff and Dedicated Volunteers. The city has highly experienced and knowledgeable staff and a variety of crew personnel to perform important urban forest maintenance tasks such as storm damage clean-up and correction, tree planting, permit review, and priority and citizen-requested street tree removals and pruning. St. Augustine's urban forest management staff are engaged in professional organizations and have been recognized locally and nationally for their leadership by their peers. The Street Tree Advisory Committee has broad representation and assists staff with special projects and program advancement. The expertise of city staff and the support of the Street Tree Advisory Committee have resulted in St. Augustine being recognized as a Tree City, USA for over three decades.

Challenges

Insect and Disease Threats are Increasing. Many non-native, invasive insects and diseases, Fusarium wilt (*Fusarium oxysporum* f. sp. *palmarum)*, Ganoderma butt rot of palms (*Ganoderma zonatum*), and granulate ambrosia beetle (*Xylosandrus crassiusculus*), pose serious threats to a large percentage of St. Augustine's public and private urban forest. While infestations of these pests were not confirmed in St. Augustine, the possibility continues for spread and establishment of these and other known and unknown invasive forest pests. A more comprehensive approach to species diversity planning and integrated pest management is needed.

Severe Weather Events. High winds and heavy rains from hurricanes and tornadoes cannot be prevented, and these events cause significant tree damage and canopy loss. However, preventive maintenance of public trees and purposeful planting can significantly reduce the types and amounts of storm damage. St. Augustine needs to establish a citywide preventive, cyclical maintenance program and plant storm-resilient tree species.

Climate Change. Beyond contributing to severe weather events and flooding, climate change may cause shifts in average temperatures and moisture levels. Trees adapted to St. Augustine's historic climate may soon become stressed and more prone to insects and disease as the climate changes over time.

Most Trees Are Under Private Care. In St. Augustine, the vast majority of the tree canopy is located on private lands. For this reason, success in improving or maintaining tree canopy must include a citizenry that understands: 1) the value of trees and tree canopy to the community; and 2) how to plant and care for trees. Without this awareness and information, mature trees can be removed at any time without a thought of the loss of benefits to the property owner, or overall impact on the community. And, replacement trees might not be planted, or if they are they may be poorly placed and selected.

WHAT DO WE HAVE? --------
THE STATE OF ST. AUGUSTINE'S URBAN FOREST

As part of the answer to the question "What do we have now?", the existing urban forest in St. Augustine was assessed. The characteristics of and benefits produced by the citywide UTC and the public urban forest are important to know for developing proactive management policies that protect and enhance the safety and sustainability of this important natural resource.

The urban forest within a city can be considered in two different ways. First, it can be defined as the entire population of trees (whether they are naturally occurring forests or human-planted landscape trees) growing on both public and private property within municipal boundaries. They are considered a community resource because they provide many benefits to everyone regardless of location or ownership. Collectively, trees on public and private property are generally referred to as the community's urban tree canopy (UTC).

Trees that are on public property (such as on streets, in parks, and near public facilities) and managed by the city are a subset of the urban tree canopy and are collectively referred to as the public urban forest.

Assessment of the Urban Tree Canopy

The amount and distribution of the urban tree canopy (UTC) determine the urban forest's capacity for providing environmental and social benefits to the community. A community's UTC is expressed as a percentage of all land and is composed of all public and private trees within a community's urban forest, as viewed from above the trees. Recognizing the importance of UTC, St. Augustine wanted to know more about their citywide UTC and requested an i-Tree Canopy analysis be performed to determine land cover percentages and tree benefits on a citywide basis.

Citywide Tree Canopy Cover

Based on the use of i-Tree Canopy, the estimated canopy coverage of St. Augustine is 24% (or approximately 1,963 acres). The results of the 2017 UTC analysis, estimates for all land cover types, are provided in Table 1. The boundary of St. Augustine's city limits covers approximately 12.78 square miles (8,179 acres).

Table 1. i-Tree Canopy Results for St. Augustine

Land Cover Classification	2017 i-Tree Canopy Assessment
Tree Canopy	24%
Impervious Surfaces	15%
Grass & Low Vegetation	20%
Bare Soils	9%
Open Water	32%

However, since St. Augustine is a coastal city with significant inland waterways, a better way to estimate the UTC is to remove the open water acres from the UTC percentage calculation. When that is done, the resulting citywide UTC is approximately 35%.

The i-Tree Canopy tool can be used by St. Augustine in future land cover assessments to provide land cover analysis using new aerial images as they become available in Google® Maps. This can also produce findings on where the changes in canopy have taken place and why. Details on i-Tree Canopy analysis and future options for analysis can be found in Appenix A. The random point locations derived from the i-Tree Canopy project performed for this plan can be re-imported in future analyses to produce a statistically valid estimate of land cover. The i-Tree Canopy data and project file have been delivered to the city for such future analyses.

Public Tree Canopy Cover

In St. Augustine, the estimated public tree canopy cover (street and park trees) is 38 acres of the total land area within city limits. This is less than 1% of the total land area and nearly 2% of the estimated UTC. Throughout the United States, street trees often represent less than 10% of a city's UTC (Moll and Kollin 1993).

Streets widths and sidewalk widths in St. Augustine average 20 feet and 4 feet, respectively, and there are about 75 miles of streets. The calculated tree canopy coverage of streets and sidewalks is 15% of the estimated street and sidewalk area (255 acres) within the city.

What Canopy Percent Should We Be Aiming For?

American Forests, a recognized leader in conservation and community forestry, has established standards and goals for canopy cover in metropolitan areas. They recommend that cities set an overall canopy goal of 40%, a 15% canopy in central business districts, 25% canopy in urban neighborhoods, and 50% canopy in suburban neighborhoods.

Recently, the South Florida Urban Tree Canopy Coalition has set a goal for communities in that region to achieve 50% tree canopy cover in residential areas, 25% cover in urban residential areas, and 10% canopy cover in the urban core.

However, every community is unique, and these goals are only to be considered general guidelines. Determining tree canopy goals for St. Augustine will involve a multi-step process of using these ideal canopy rates in combination with what is realistic and acceptable in St. Augustine when balanced with other economic and social goals of the community.

Setting Realistic Urban Tree Canopy Goals

The amount of tree canopy drives the amount of ecosystem and human benefits that trees provide a city. Once the UTC percentage and benefits are determined, every city must decide whether they want to maintain the existing canopy level, increase it, or even set a minimum threshold for its citywide tree canopy. Setting UTC goals can help define future tree planting programs and direct tree preservation efforts. Establishing realistic and achievable tree canopy goals will help capitalize on the economic, environmental, and social benefits trees provide to the community.

How Much Canopy is Possible? If the goal is to increase its tree canopy, then potentially every acre of land that is not paved (impervious) could support trees. This "Possible UTC" then is the sum of all land cover that is open, pervious ground (i.e., tree canopy, grass and low vegetation, and bare soil). In St. Augustine, "Possible UTC" is 53% of the total land area within city limits.

However, open ground within municipal boundaries is also used for athletic fields, cemeteries, and other land uses important to a livable city. Therefore, it is not practical to consider the "Possible UTC" as a goal.

"Realistic UTC", areas where planting is more practical, is based on the approach of identifying reasonable areas to plant trees. St. Augustine should identify, assess, and prioritize these areas based on maximizing ecological services, providing equal access to trees and natural resources, and protecting public health and safety benefits. Realistic planting areas would include the pervious surfaces within state corridors, highways, streets, parks, public properties, and private property within St. Augustine. Land uses, such as agricultural land, cemeteries, golf courses, utility rights-of-way, and recreational fields, would be excluded from the analysis. Knowing where and how much is "realistic UTC" in St. Augustine will make canopy goal setting more practical and achievable.

Assessment of Public Trees

In July 2017, DRG arborists assessed and inventoried trees and planting sites along the street ROW, specified parks, and public facilities on the mainland; no trees on the island were included in the inventory. A total of 2,968 sites were collected during the inventory: 2,928 trees and 40 planting sites. Of the 2,968 sites collected, 60% were collected along the street ROW, and the remaining 40% were collected in parks. Figure 1 displays the locations of the inventoried sites, and additional maps are found in Appendix B.

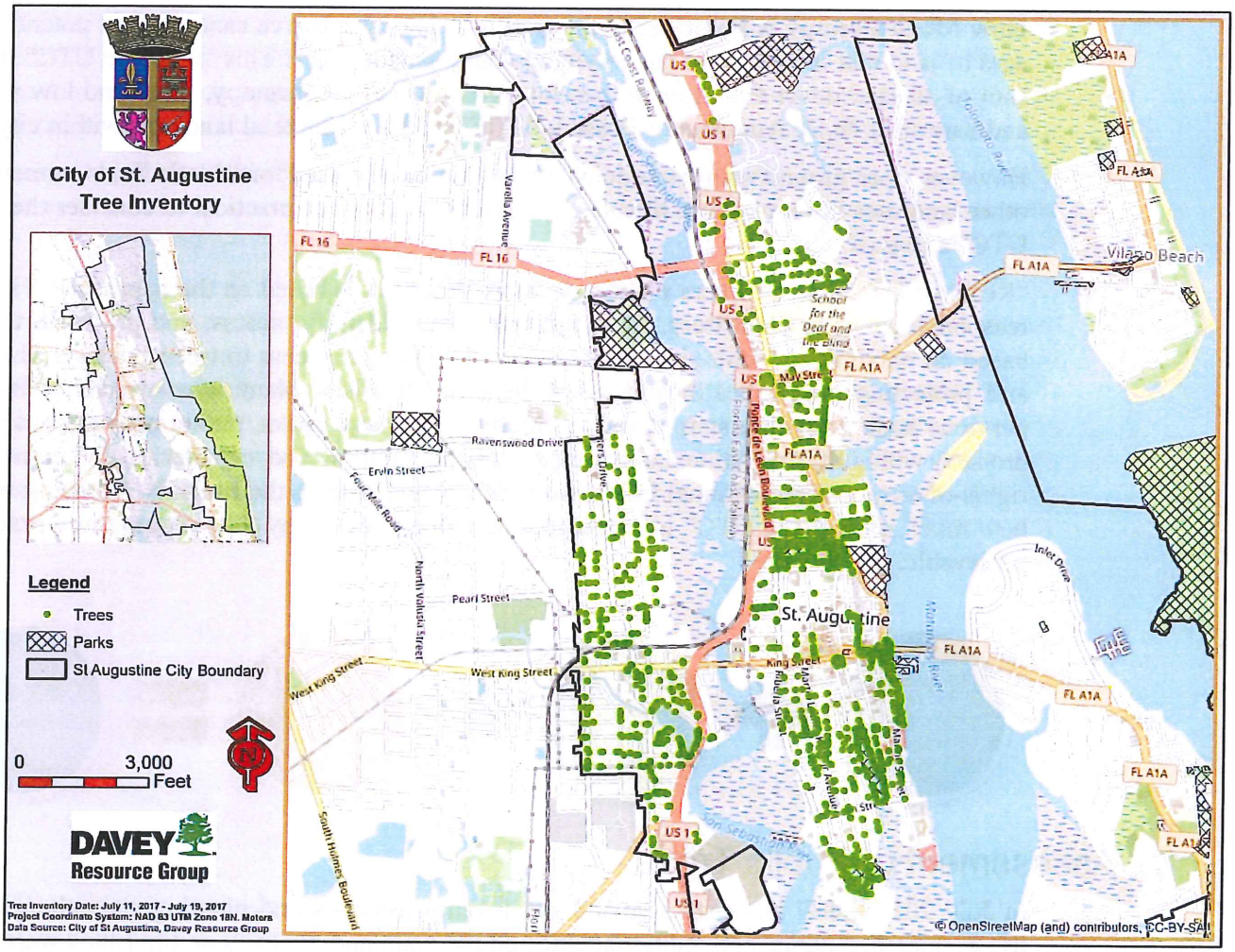


Figure 1. Sites collected on the mainland during the 2017 inventory.

The locations of public trees were primarily in residential sections of the city followed closely by park areas. Figure 2 provides a detailed breakdown of the number and type of sites inventoried.

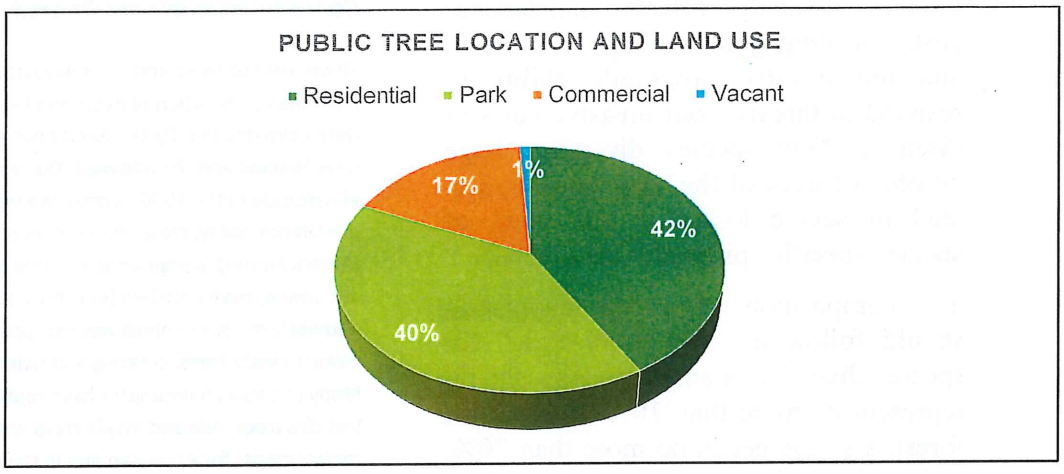
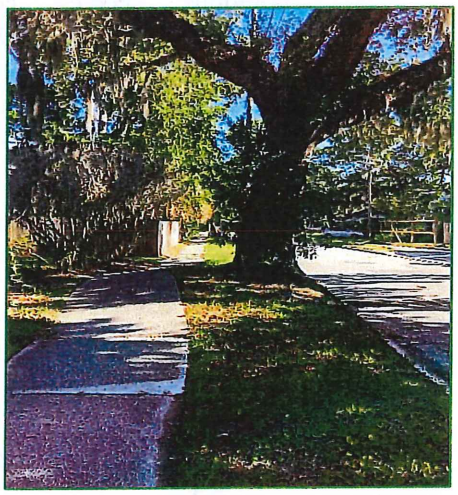


Figure 2. 2017 tree inventory sites by land use type.

Data analysis and professional judgment were used to generally characterize the state of the inventoried tree population. Recognizing trends in the data can help guide short-term and long-term management planning. In this plan, the following criteria and indicators of the inventoried tree population were assessed:

- *Species Diversity*, the variety of species in a specific population, affects the population's ability to withstand threats from invasive pests and diseases. Species diversity also impacts tree maintenance needs and costs, tree planting goals, and canopy continuity.
- *Diameter Size Class Distribution Data*, the statistical distribution of a given tree population's trunk-size class, is used to indicate the relative age of a tree population. The diameter size class distribution affects the valuation of tree-related benefits as well as the projection of maintenance needs and costs, planting goals, and canopy continuity.
- *Condition*, the general health of a tree population, indicates how well trees are performing given their site-specific conditions. General health affects both short-term and long-term maintenance needs and costs as well as canopy continuity.



Photograph 1. Davey's *ISA*-Certified Arborists inventoried trees along street ROW and in community parks to collect information about trees that could be used to assess the state of the urban forest.

- *Stocking Level* is the proportion of existing street ROW trees compared to the total number of potential street ROW trees (number of inventoried trees plus the number of potential planting spaces); stocking level can help determine tree planting needs and budgets.
- *Other Observations* include inventory data analysis that provides insight into past maintenance practices and growing conditions; such observations may affect future management decisions.

Species Diversity

Species diversity affects maintenance costs, planting goals, canopy continuity, and the forestry program's ability to respond to threats from invasive pests or diseases. Low species diversity (large number of trees of the same species) can lead to severe losses in the event of species-specific epidemics (see sidebar).

The composition of a tree population should follow the "10-20-30 Rule" for species diversity: a single species should represent no more than 10% of the urban forest, a single genus no more than 20%, and a single family no more than 30%. Figure 3 shows the composition of the most populous species compared to all inventoried species. Of all the species inventoried in St. Augustine, *Quercus virginiana* (live oak) is the only one that exceeds the 10% threshold, comprising 16% of the total population.

Consequences of Low Diversity

There have been a number of devastating results resulting from the combination of pests and lack of species diversity. Dutch elm disease (*Ophiostoma novo-ulmi*) is throughout New England and the Midwest. Due to the spread of Dutch elm disease in the 1930s, combined with the disease's prevalence today, massive numbers of *Ulmus americana* (American elm), a popular street tree in Midwestern cities and towns, have perished (Karnosky 1979). Several Midwestern communities were stripped of most of their mature shade trees, creating a drastic void in canopy cover. Many of these communities have replanted to replace the lost elm trees. Ash and maple trees were popular replacements for American elm in the wake of Dutch elm disease. Unfortunately, some of the replacement species for American elm trees are now overabundant, which is a biodiversity concern. EAB and Asian longhorned beetle (ALB, *Anoplophora glabripennis*) are non-native insect pests that attack some of the most prevalent urban shade trees and certain agricultural trees throughout the country.

There are 26 genera and 30 species represented within St. Augustine's public tree population. Along the street ROW, diversity was greater and contained 17 more species than that of the park tree population.

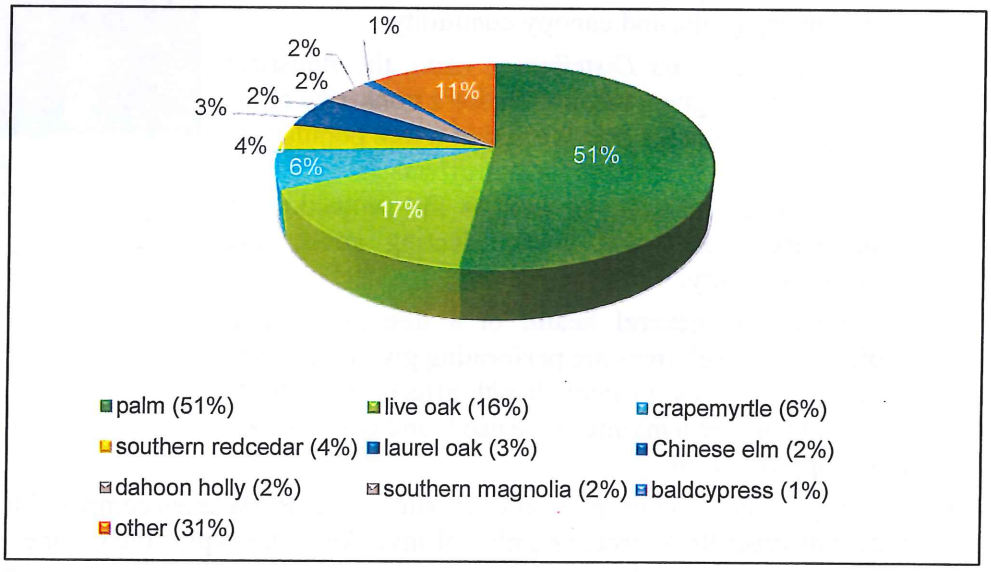
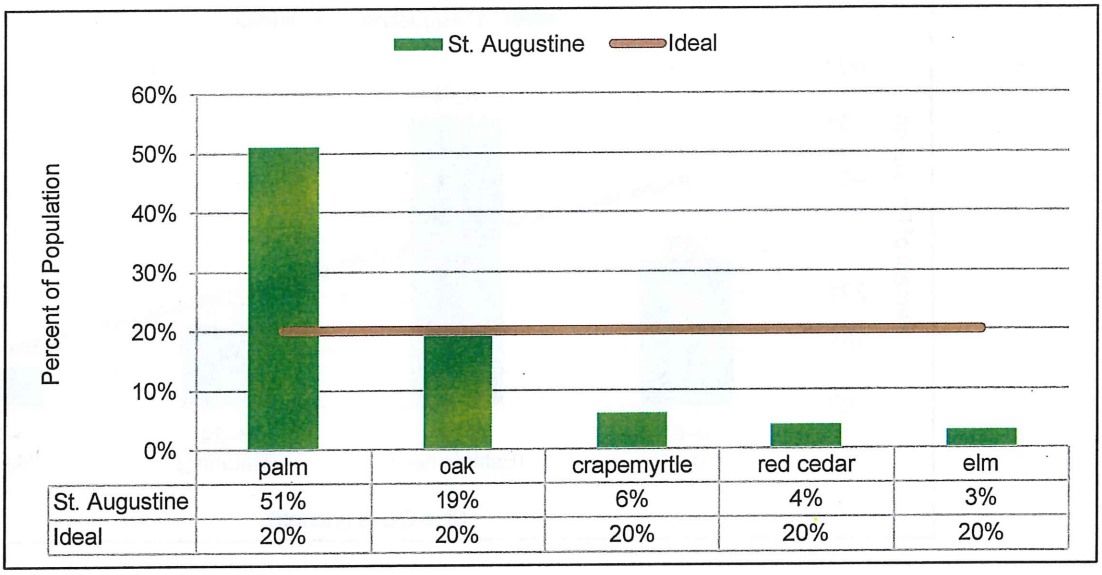


Figure 3. Tree species distribution and composition in St. Augustine, Florida.

Figure 4 compares the percentages of the most common genera inventoried to the 20% Rule. The oak genus falls just below the 20% threshold for any one tree genus. Individual palm species were not differentiated during the inventory, but the combined palm family (51%) far exceeded the recommended 30% threshold for any single family. Generally, species diversity in St. Augustine's urban forest is low, with oak and palm species representing a combined 70% of the population.



	palm	oak	crapemyrtle	red cedar	elm
St. Augustine	51%	19%	6%	4%	3%
Ideal	20%	20%	20%	20%	20%

Figure 4. Five most abundant genera of the inventoried population compared to the 20% Rule.

Palm tree species dominate the streets and parks. This is a biodiversity concern because its abundance in the landscape makes it a limiting species. Continued diversity of tree species is an important objective that will ensure St. Augustine's urban forest is sustainable and resilient to future invasive pest infestations.

Considering the large quantity of *Quercus virginiana* (live oak) in St. Augustine's population, along with its susceptibility to oak wilt and other fungal diseases, the planting of *Q. virginiana* (live oak) should be limited to minimize the potential for loss in the event that oak wilt threatens St. Augustine's urban tree population. See Action Step 2 for options and recommendations to improve diversity; Appendix D has a recommended tree species list for planting.

Distribution of Tree Sizes/Ages

Analyzing the diameter size class distribution provides an estimate of the relative age of a tree population and offers insight into maintenance practices and needs.

The inventoried trees were categorized into the following diameter size classes: young trees (0–8 inches DBH), established (9–17 inches DBH), maturing (18–24 inches DBH), and mature trees (greater than 24 inches DBH). These categories were chosen so that the population could be analyzed according to Richards' ideal distribution (1983). Richards proposed an ideal diameter size class distribution for street trees based on observations of well-adapted trees in Syracuse, New York. Richards' ideal distribution suggests that the largest fraction of trees (approximately 40% of the population) should be young (less than 8 inches DBH), while a smaller fraction (approximately 10%) should be in the large-diameter size class (greater than 24 inches DBH). A tree population with an ideal distribution would have an abundance of newly planted and young trees, and lower numbers of established, maturing, and mature trees.

Figure 5 compares St. Augustine's age/size class distribution of the inventoried tree population to the recommended levels. St. Augustine's distribution trends towards the ideal; young trees fall short of the ideal by over 10%, while maturing and mature size classes also fall short of the ideal. Established trees represent 52% of the tree population, falling well above the ideal by 20%.

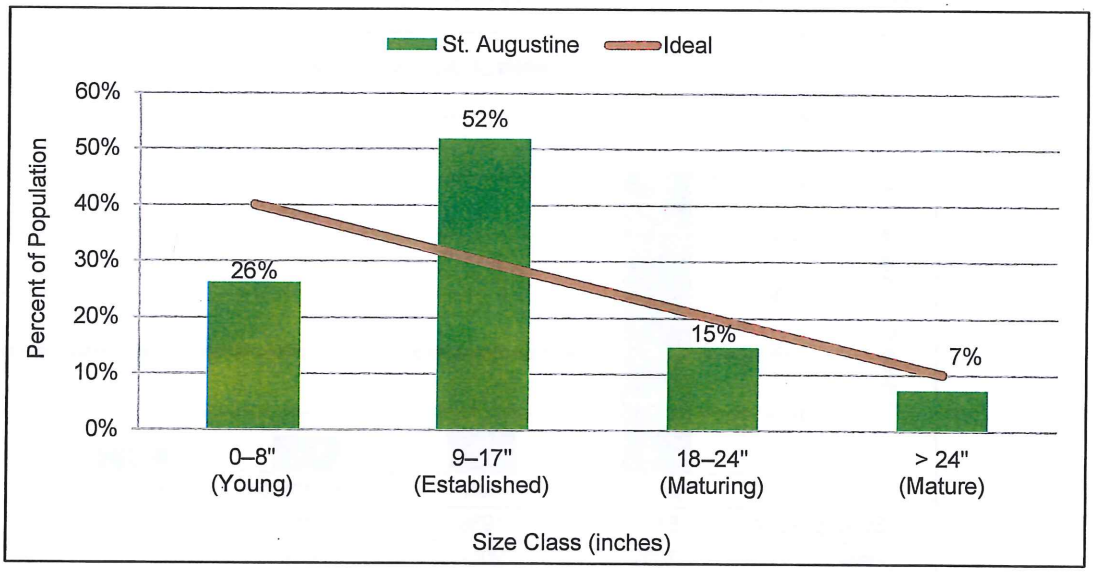


Figure 5. Comparison of diameter size class and relative age distribution for inventoried trees to the ideal distribution.

Planting trees is necessary to increase canopy cover and replace trees lost to natural mortality (expected to be 1%–3% per year) and other threats (for example, invasive pests or impacts from weather events such as storms, wind, ice, snow, flooding, and drought). Planning for the replacement of existing trees and identifying the best places to create new canopy is critical.

Condition of Public Trees

DRG assessed the condition of individual trees based on methods defined by the International Society of Arboriculture (ISA). Several factors were considered for each tree, including: root characteristics, branch structure, trunk, canopy, foliage condition, and the presence of pests. The condition of each inventoried tree was rated Good, Fair, Poor, or Dead.

In this plan, the general health of the inventoried tree population was characterized by the most prevalent condition assigned during the inventory.

Comparing the condition of the inventoried tree population with relative tree age (or size class distribution) can provide insight into the stability of the population. Since tree species have different lifespans and mature at different diameters, heights, and crown spreads, actual tree age cannot be determined from diameter size class alone. However, general classifications of size can be extrapolated into relative age classes. The following categories are used to describe the relative age of a tree: young (0–8 inches DBH), established (9–17 inches DBH), maturing (18–24 inches DBH), and mature (greater than 24 inches DBH).

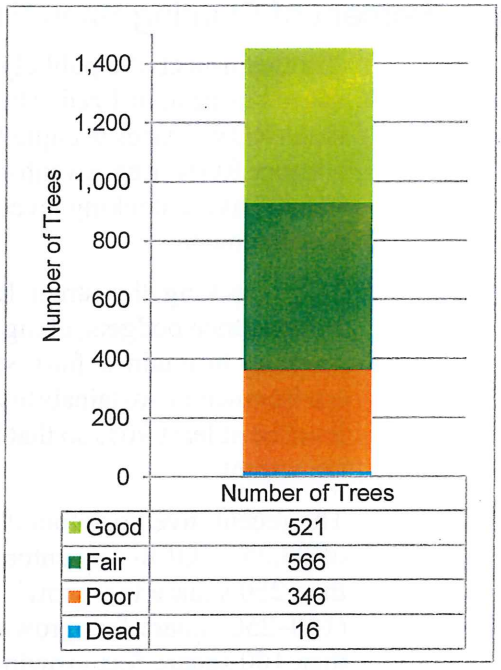


Figure 6. Conditions of inventoried trees.

Figures 6 and 7 illustrate the general health and distribution of young, established, mature, and maturing trees relative to their condition.

Almost 75% of the inventoried trees were recorded to be in fair or better condition, 36% and 39%, respectively (Figure 6). Based on these data, the general health of the overall inventoried tree population is rated fair. Figure 7 illustrates that most of the young and established trees were rated to be in good condition, and that most of the maturing and mature trees were rated to be in fair condition.

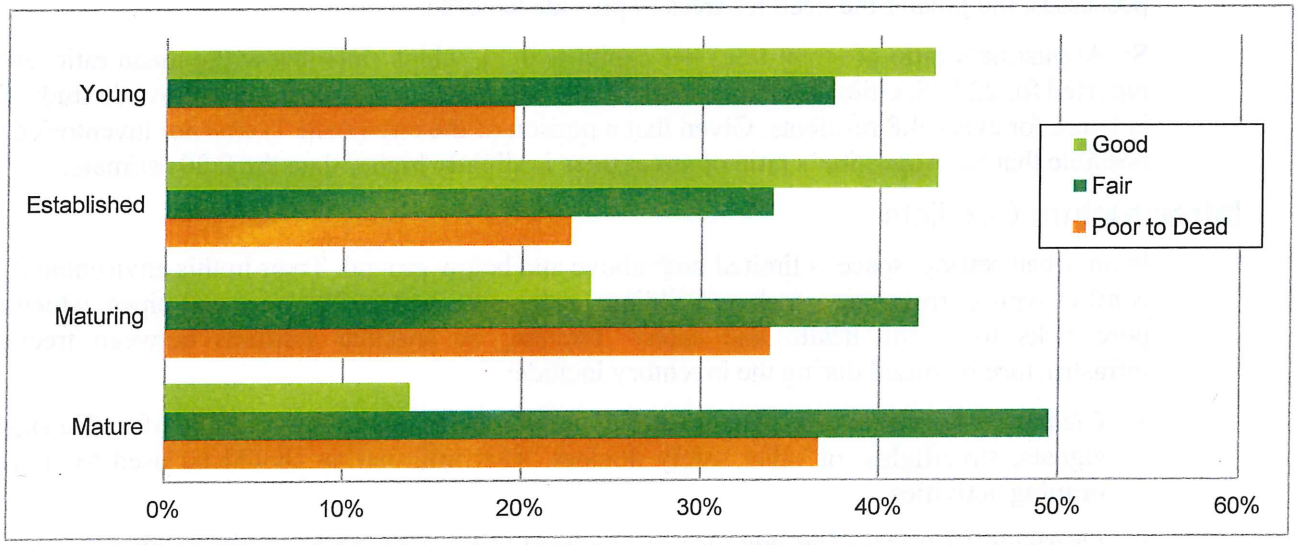


Figure 7. Tree condition by relative age during the 2017 inventory.

Percent of Planting Sites Filled (Stocking Level)

Another aspect of a publicly-owned urban forest to examine is how much of the available planting space has been utilized. This can be measured using stocking levels. Stocking level is the ratio of street ROW spaces occupied by trees to the total street ROW spaces suitable for trees. For example, a street ROW tree inventory of 1,000 total sites with 750 existing trees and 250 planting sites would have a stocking level of 75%. Park and other non-street public trees are excluded from this measurement.

Fully stocking the street ROW with trees is an excellent goal. Inadequate tree planting and maintenance budgets, along with tree mortality, will result in lower stocking levels. Nevertheless, working to attain a fully stocked street ROW is important to promote canopy continuity and environmental sustainability. For St. Augustine, DRG recommends that the street ROW stocking level be at least 90% so that no more than 10% of the potential planting sites along the street ROW are vacant.

The recent inventory found 40 vacant planting sites which equates to a ROW tree stocking level of 98.25%. Of the inventoried sites, 8 were potential planting sites for large-sized trees (greater than 250 square feet growing space size); 10 were potential planting sites for medium-sized trees (100–250 square feet growing space size); and 22 were potential sites for small-sized trees (less than 100 square feet growing space size).

Since St. Augustine has already exceeded the recommended stocking baseline of 90%, their focus should be on maintaining that level through tree plantings, young tree training, and maintenance of their existing street tree population.

Related to stocking statistics and goals, calculations of trees per capita are important in determining the density of St. Augustine's urban forest. The more residents and greater housing density a city possesses, the greater the need for trees to provide benefits.

St. Augustine's ratio of street trees per capita is 0.20, which falls below the mean ratio of 0.37 reported for 22 U.S. cities (McPherson and Rowntree 1989). According to the citywide study, there is 1 tree for every 4.8 residents. Given that a portion of the city (Zone 1) was not inventoried, it is possible that St. Augustine's ratio of street trees is slightly higher than the 0.20 estimate.

Infrastructure Conflicts

In an urban setting, space is limited both above and below ground. Trees in this environment may conflict with infrastructure such as buildings, sidewalks, and utility wires and pipes, which may pose risks to public health and safety. Existing or possible conflicts between trees and infrastructure recorded during the inventory include:

- *Clearance Requirements*—The inventory noted trees blocking the visibility of traffic signs or signals, streetlights, or other safety devices. This information should be used to schedule pruning activities.
- *Overhead Utilities*—The presence of overhead utility lines above a tree or planting site was noted; it is important to consider these data when planning pruning activities and selecting tree species for planting.

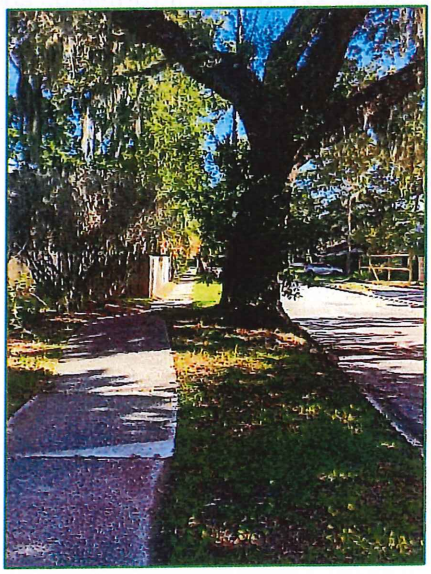
- *Hardscape Damage*—Trees can adversely impact hardscape, which affects tree root and trunk systems. The inventory recorded damage related to trees, causing curbs, sidewalks, and other hardscape features to lift. These data should be used to schedule pruning and plan repairs to damaged infrastructure. To limit hardscape damage caused by trees, trees should only be planted in growing spaces where adequate above ground and below ground space is provided.

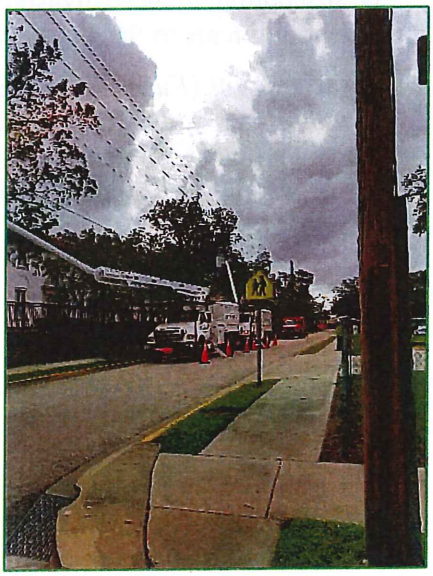
  There were 843 trees (nearly 30% of the population) with utilities directly above, or passing through, the tree canopy. Of those trees, 27% were large- or medium-size trees.

  Hardscape damage was minimal; only 23 (0.8% of the tree population) had conflicts with raised sidewalk slabs or curbs.

Table 2. Trees Noted to be Conflicting with Infrastructure

Infrastructure Conflict	Presence	Number of Trees	Percent
Utilities and Structures	Overhead Wires	843	28.8%
	Buildings	78	2.7%
	Lights	23	0.8%
	Not Present	1,984	67.8%
Hardscape Damage	Present	23	0.8%
	Not Present	2,905	99.2%
Total		2,928	100%





Photographs 2 and 3. While not common, the inventory did find trees in conflict with aerial utility lines and sidewalks and curbs.

Tree canopy should not interfere with vehicular or pedestrian traffic, nor should it rest on buildings or block signs, signals, or lights. Pruning to avoid clearance issues and raise tree crowns should be completed in accordance with *ANSI A300 (Part 9)* (2011). DRG's clearance distance guidelines are as follows: 14 feet over streets; 8 feet over sidewalks; and 5 feet from buildings, signs, signals, or lights.

Planting only small-growing trees within 20 feet of overhead utilities, medium-size trees within 20–40 feet, and large-growing trees outside 40 feet will help improve future tree conditions, minimize future utility line conflicts, and reduce the costs of maintaining trees under utility lines.

When planting around hardscape, it is important to give the tree enough growing room above ground. Guidelines for planting trees among hardscape features are as follows: give small-growing trees 4–5 feet; medium-growing trees 6–7 feet; and large-growing trees 8 feet or more between hardscape features. In most cases, this will allow for the spread of a tree's trunk taper, root collar, and immediate larger-diameter structural roots.

Potential Threats from Pests

Insects and diseases pose serious threats to tree health. Awareness and early diagnosis are essential to ensuring the health and continuity of street and park trees.

Many pests target a single species or an entire genus. The inventory data were analyzed to provide a general estimate of the percentage of trees susceptible to some of the known pests in Florida (see Figure 8). It is important to note that the figure only presents data collected from the inventory. Many more trees throughout St. Augustine, including those on public and private property, may be susceptible to these invasive pests. Appendix C provides information about some of the current potential threats to St. Augustine's trees.

Fusarium wilt (*Fusarium oxysporum* f. sp. *palmarum)*, Ganoderma butt rot of palm (*Ganoderma zonatum*), and granulate ambrosia beetle (*Xylosandrus crassiusculus*) are known threats to a large percentage of the inventoried street trees (51%, 51%, and 33%, respectively). These pests were not detected in St. Augustine, but if they were detected St. Augustine could see severe losses in its tree population.

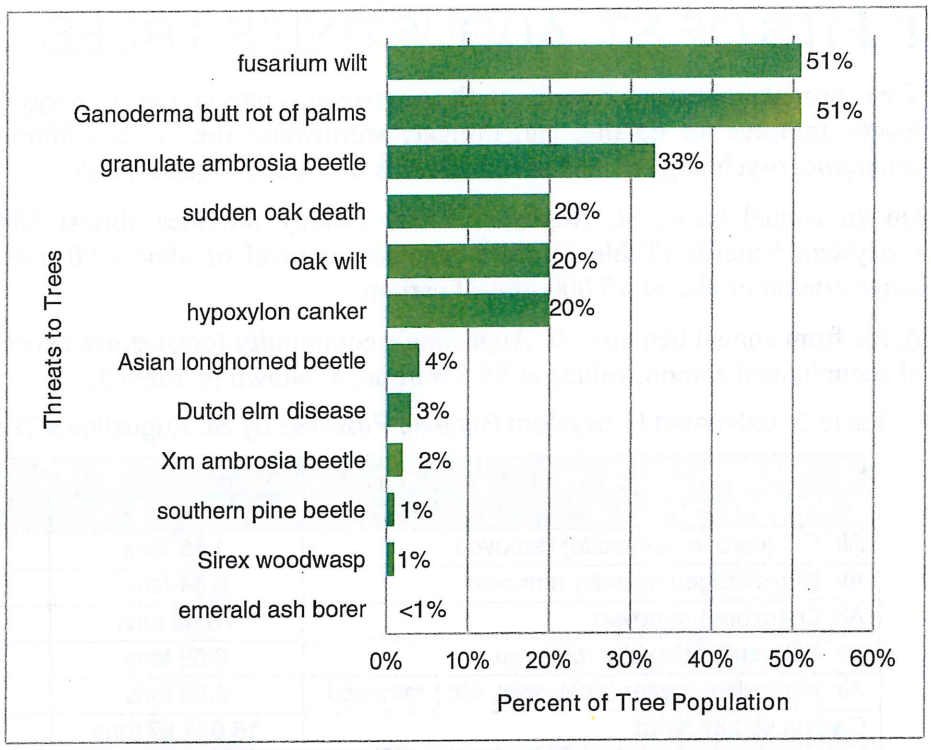


Figure 8. Potential impact of insect and disease threats noted during the 2017 inventory.

St. Augustine should be aware of the signs and symptoms of potential infestations and should be prepared to act if a significant threat is observed in its tree population or a nearby community. An integrated pest management plan should be established. The plan should focus on identifying and monitoring threats, understanding the economic threshold, selecting the correct treatment, properly timing management strategies, recordkeeping, and evaluating results.

BENEFITS OF ST. AUGUSTINE'S TREES

Trees provide numerous benefits to St. Augustine. Trees conserve energy, reduce carbon dioxide levels, improve air quality, and mitigate stormwater runoff. In addition, trees provide many economic, psychological, and social benefits that are less quantifiable.

On an annual basis, St. Augustine's tree canopy provides almost $894,000 in quantifiable ecosystem benefits (Table 3). This includes removal of almost 90 tons of air pollutants and sequestration of almost 15,000 tons of carbon.

Aside from annual benefits, St. Augustine's community forest stores approximately 244,000 tons of accumulated carbon, valued at $8.6 million, as shown in Table 3.

Table 3. Estimated Ecosystem Benefits Provided by St. Augustine's Tree Canopy in 2017

St. Augustine's Tree Canopy Ecosystem Benefits	Annual Benefits	
	Quantity	Value
Air: CO (carbon monoxide) removed	1.65 tons	$2,188
Air: NO_2 (nitrogen dioxide) removed	9.54 tons	$2,670
Air: O_3 (ozone) removed	73.05 tons	$149,060
Air: SO_2 (sulfur dioxide) removed	2.59 tons	$304
Air: particulate matter (dust, soot, etc.) removed	2.90 tons	$208,875
Carbon sequestered	15,067.87 tons	$531,220
Total Annual Benefits		$894,320
Current stored carbon*	243,940.83 tons	$8,600,225

* Current stored carbon is not an annual value but rather a measurement of the total contribution of storage over the life of the tree canopy.

The urban forest plays an important role in supporting and improving the quality of life in St. Augustine. A tree's shade and beauty contribute to a community's quality of life and soften the often hard appearance of urban landscapes and streetscapes. When properly maintained, trees provide communities abundant environmental, economic, and social benefits that far exceed the time and money invested in planting, pruning, protection, and removal.

Environmental Benefits

- Trees decrease energy consumption and moderate local climates by providing shade and acting as windbreaks.
- Trees act as mini-reservoirs, helping to slow and reduce the amount of stormwater runoff that reaches storm drains, rivers, and lakes. One hundred mature tree crowns intercept roughly 100,000 gallons of rainfall per year (U.S. Forest Service 2003a).
- Trees help reduce noise levels, cleanse atmospheric pollutants, produce oxygen, and absorb carbon dioxide.
- Trees can reduce street-level air pollution by up to 60% (Coder 1996). Lovasi (2008) suggested that children who live on tree-lined streets have lower rates of asthma.
- Trees stabilize soil and provide a habitat for wildlife.

Economic Benefits

- Trees in a yard or neighborhood increase residential property values by an average of 7%.
- Commercial property rental rates were 7% higher when trees are on the property (Wolf 2007).
- Trees moderate temperatures in the summer and winter, saving on heating and cooling expenses (North Carolina State University 2012, Heisler 1986).
- On average, consumers will pay about 11% more for goods in landscaped areas, with this figure being as high as 50% for convenience goods (Wolf 1998b, Wolf 1999, and Wolf 2003).
- Consumers also feel that the quality of products is better in business districts surrounded by trees than those considered barren (Wolf 1998b).
- The quality of landscaping along the routes leading to business districts had a positive influence on consumers' perceptions of the area (Wolf 2000).

Social Benefits

- Tree-lined streets are safer; traffic speeds and the amount of stress drivers feel are reduced, which likely reduces road rage/aggressive driving (Wolf 1998a, Kuo and Sullivan 2001a).
- Chicago apartment buildings with medium amounts of greenery had 42% fewer crimes than those without any trees (Kuo and Sullivan 2001b).
- Chicago apartment buildings with high levels of greenery had 52% fewer crimes than those without any trees (Kuo and Sullivan 2001a).
- Employees who see trees from their desks experience 23% less sick time and report greater job satisfaction than those who do not (Wolf 1998a).
- Hospital patients recovering from surgery who had a view of a grove of trees through their windows required fewer pain relievers, experienced fewer complications, and left the hospital sooner than similar patients who had a view of a brick wall (Ulrich 1984, 1986).
- When surrounded by trees, physical signs of personal stress, such as muscle tension and pulse rate, were measurably reduced within three to four minutes (Ulrich 1991).

The trees growing in a city constitute a valuable community resource. They provide numerous tangible and intangible benefits, such as pollution control, energy reduction, stormwater management, property value increases, wildlife habitat, education, and aesthetics.

The services and benefits of trees in the urban and suburban setting were once considered to be unquantifiable. However, by using extensive scientific studies and practical research, these benefits can now be confidently calculated using tree inventory information. The results of applying a proven, defensible model and method that determine tree benefit values for the City of St. Augustine's UTC and its public trees are summarized in this plan using the U.S. Forest Service's i-Tree's Canopy and Streets applications (Appendix A describes i-Tree methods).

Citywide Urban Tree Canopy Benefit Analysis

The ecosystem benefits of the St. Augustine's UTC resource were quantified using the i-Tree Canopy model. In addition to its ability to estimate tree canopy and other land cover types within any selected geography, i-Tree Canopy also estimates carbon storage and sequestration and air pollutant removal. Each of these benefits are described in more detail below.

Air Quality Improvements. Trees improve a city's air quality in many ways. Not only do trees absorb carbon dioxide and produce oxygen, but they can also capture pollutants and particulate matter on the surfaces of their leaves. Sulfur dioxide is a contributor to acid rain, while carbon monoxide and nitrogen dioxide are greenhouse gases that contribute to changes in global climate. Ozone and particulate matter, on the other hand, can exacerbate asthma and other respiratory illnesses. In fact, recent studies have shown a strong correlation between total tree canopy and reduced rates of pulmonary and cardiovascular disease due to the air cleaning qualities of trees.

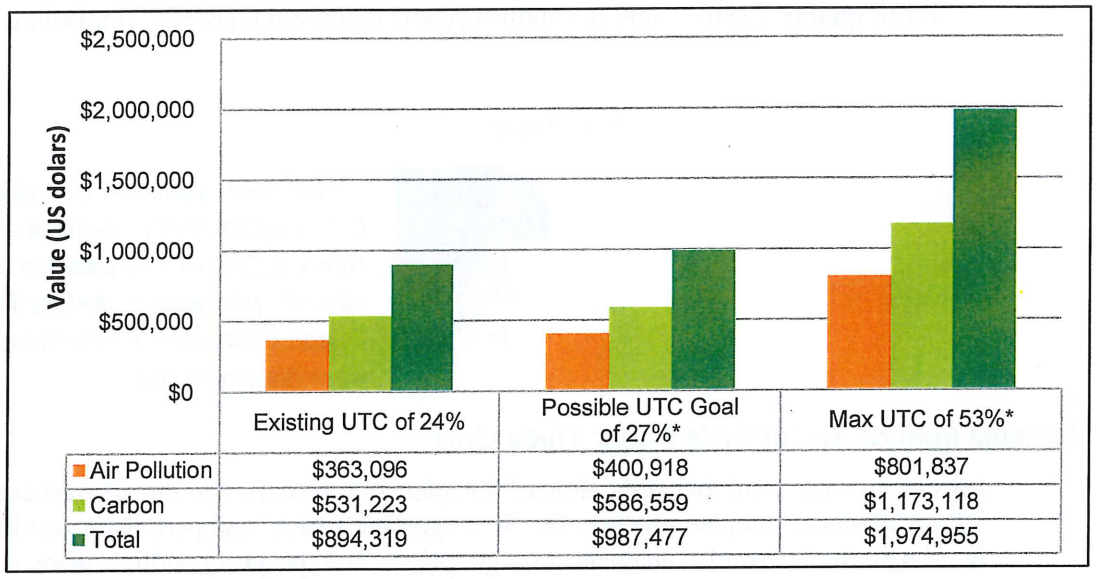
Every year, St. Augustine's tree canopy removes roughly 90 tons of pollutants from the air, including 1.65 tons of carbon monoxide (CO); 9.54 tons of nitrogen dioxide (NO_2); approximately 73.05 tons of ozone (O_3); 2.59 tons of sulfur dioxide (SO_2); and approximately 2.90 tons of dust, soot, and other particulate matter. The combined removal of pollutants results in an annual value of over $363,000 in air quality improvements.

Carbon Reduction. Trees store a massive amount of carbon in their woody tissue. Carbon is a greenhouse gas that directly influences climate change. Forests, both urban and rural, are an important carbon sink, helping to mitigate climate change. In total, St. Augustine's community forest stores almost 244,000 tons of carbon, which equates to $8.6 million in value (based on current carbon markets). Based on values provided by the Environmental Protection Agency, this benefit reflects the amount of carbon produced by burning 100.6 million gallons of gasoline. Each year, an additional 15,068 tons of carbon are sequestered for an annual value of $531,223. This storage helps offset the amount of carbon in the air (Nowak, D. J., E. J. Greenfield, R. E. Hoehn, and E. Lapoint. 2013. "Carbon storage and sequestration by trees in urban and community areas of the United States." *Environmental Pollution* 178(July):229-236. doi:10.1016).

Forecasting the Urban Tree Canopy Benefit

Data analysis shows St. Augustine's existing UTC of 24% provides an estimated $894,319 in annual benefits and savings to the community. Using i-Tree Canopy and calculated acreages of tree canopy under various scenarios, the future increases in benefits can be estimated. Figure 9 lists the total annual ecosystem benefits and illustrates projected ecosystem benefits based on St. Augustine's current canopy cover extent of 24%, a modest increase to 27% UTC, and the maximum potential of 53% tree cover.

Increasing UTC by about 3% may produce an increase of nearly 10% in annual benefits and values. Maximizing UTC by a 47% increase may produce an increase in annual benefits and values of nearly 32%. The projected values in Figure 9 were extrapolated based on existing conditions.



	Existing UTC of 24%	Possible UTC Goal of 27%*	Max UTC of 53%*
Air Pollution	$363,096	$400,918	$801,837
Carbon	$531,223	$586,559	$1,173,118
Total	$894,319	$987,477	$1,974,955

Figure 9. Projected annual ecosystem benefits comparison between current canopy and two future canopy cover scenarios.

Public Tree Benefit Analysis

In order to identify the dollar value provided and returned to the community, the city's public tree inventory data were formatted for use in the i-Tree Streets benefit-cost assessment tool. i-Tree Streets, a component of i-Tree Tools, analyzes an inventoried tree population's structure to estimate the costs and benefits of that tree population. The assessment tool creates an annual benefit report that demonstrates the value public trees provide to a community:

These quantified benefits and the reports generated are described below.

- **Aesthetic/Other Benefits:** Shows the tangible and intangible benefits of trees reflected by increases in property values (in dollars).
- **Stormwater:** Presents reductions in annual stormwater runoff due to rainfall interception by trees measured in gallons.

- **Energy:** Presents the contribution of the urban forest towards conserving energy in terms of reduced natural gas use in the winter (measured in therms [thm]) and reduced electricity use for air conditioning in the summer (measured in Megawatt-hours ([MWh]).
- **Carbon Sequestered:** Presents annual reductions in atmospheric CO_2 due to sequestration by trees and reduced emissions from power plants due to reductions in energy use measured in pounds. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.
- **Air Quality:** Quantifies the air pollutants (ozone [O_3], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], particulate matter less than 10 micrometers in diameter [PM_{10}]) deposited on tree surfaces, and reduced emissions from power plants (NO_2, PM_{10}, volatile organic compounds [VOCs], SO_2) due to reduced electricity use in pounds. The potential negative effects of trees on air quality due to biogenic volatile organic compounds (BVOC) emissions are also reported.

i-Tree Tools

i-Tree Tools software was developed by U.S. Department of Agriculture, Forest Service (USDA FS) with the help of several industry partners, including The Davey Tree Expert Company. Learn more at www.itreetools.org.

Benefits from St. Augustine's Public Trees Only

Local data were available at the time of this plan and were used to the greatest extent possible with i-Tree Streets to calculate the benefits St. Augustine's street and park trees provide its citizens. For St. Augustine's benefit analysis, energy prices and property values were adjusted for local conditions, and air quality and stormwater costs were left as default regional values. The city provided their urban forest management costs.

The sum of environmental and economic benefits provided to the City of St. Augustine is $177,905 annually at an average of $61 per public tree and $12 per capita.

The i-Tree Streets model estimated that the inventoried public trees provide a total annual benefit of $177,905. Essentially, $177,905 was saved to cool buildings, manage stormwater, and clean the air. In addition, community aesthetics were improved and property values increased because of the presence of trees. On average, one of St. Augustine's trees provides an annual benefit of $60.76. Figure 10 summarizes the annual benefits and results for the public tree population. Table 4 presents results for individual tree species from the i-Tree Streets analysis.

The assessment found that stormwater management benefits trees provide were the greatest value to the community. Stormwater management comprises 23% of the annual benefits public trees provide. The city's public trees intercepted nearly 6.9 million gallons of rainfall, which equates to a savings of $41,296 in stormwater management costs. In addition to stormwater management savings, trees also play a major role in property value increases and energy conservation. The city's public trees improve economic growth through aesthetics by $108,006, comprising 61% of the annual benefits. The city's public trees mitigate the use of energy by $23,249, comprising 13% of the annual benefits as well. Net carbon and air quality contributions are also important and account for 3% of the annual benefits.

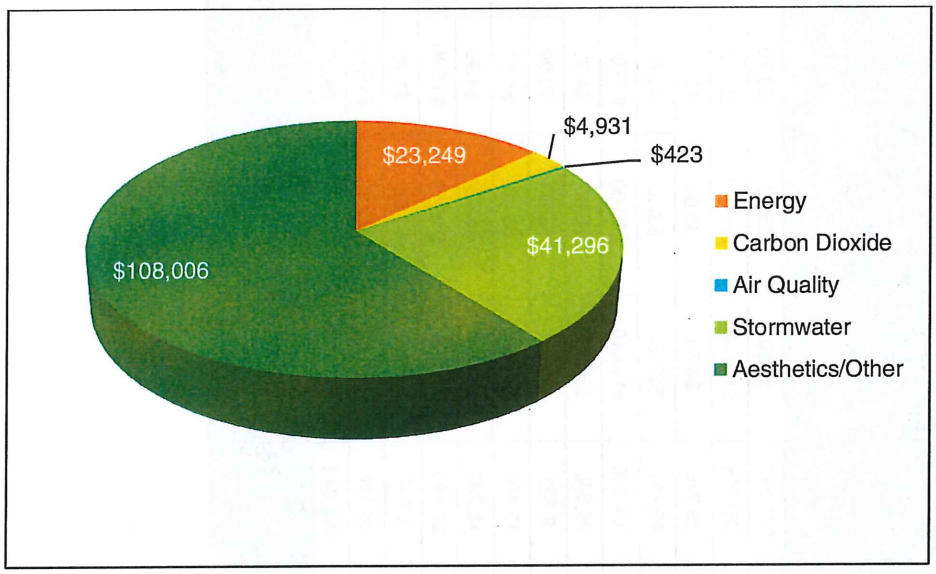


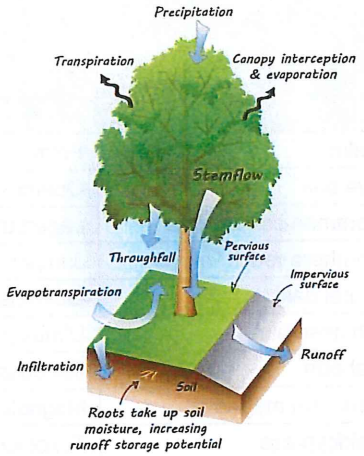
Figure 10. Breakdown of total annual benefits provided to St. Augustine.

Table 4. Benefit Data for Common Public Trees by Species

Most Common Trees Collected During Inventory		Number of Trees on the ROW	Percent of Total Trees	Canopy Cover	Benefit Provide By Public Trees					Importance Value (IV)
					Aesthetic/ Other	Stormwater	Energy	Carbon Sequestered	Air Quality	
Common Name	Botanical Name		(%)	(ft^2)	Average/$/Tree					0–100 (higher IV = more important species)
palm	Palm	1,480	51	361,297	$2.60	$5.90	$3.70	$0.50	$0.10	30.28
live oak	Quercus virginiana	483	16	823,038	$112.00	$46.70	$22.50	$5.40	-$ 1.70	40.51
common crapemyrtle	Lagerstroemia indica	165	6	25,276	$6.60	$2.00	$2.30	$0.40	$0.50	2.51
southern redcedar	Juniperus silicicola	106	4	40,452	$27.60	$8.30	$5.80	$1.80	$1.20	2.58
laurel oak	Quercus laurifolia	99	3	104,540	$118.40	$25.00	$15.00	$4.30	$2.20	5.58
Chinese elm	Ulmus parvifolia	73	2	20,342	$51.70	$5.00	$4.20	$1.20	$1.00	1.55
dahoon	Ilex cassine	49	2	9,703	$14.30	$3.20	$3.20	$1.00	$0.70	0.82
southern magnolia	Magnolia grandiflora	44	2	13,404	$37.50	$8.20	$4.50	$1.00	$0.30	1.06
baldcypress	Taxodium distichum	42	1	12,787	$45.00	$5.20	$4.90	$1.20	$0.50	0.83
sugarberry	Celtis laevigata	40	1	27,490	$73.80	$13.40	$10.80	$2.00	$2.20	1.45
Chinese privet	Ligustrum japonicum	39	1	4,707	$8.40	$2.20	$1.90	$0.60	$0.40	0.58
American sycamore	Platanus occidentalis	35	1	36,188	$176.50	$23.80	$15.70	$3.00	$1.70	2.04
other public trees	~40 species	273	9	169,942	$57.70	14.44	$8.50	$1.70	$1.00	10
Total	~52 species	2,928	100	1,649,165	$37	$14	7.94	1.68	0.14	100

Aesthetic/Other Benefits. The property value increase provided by trees is important to stimulate economic growth in St. Augustine. The total annual benefit associated with property value increases and other tangible and intangible benefits of public trees was $108,006. The average benefit per tree equaled $36.89 per year.

Stormwater Benefits. Trees intercept rainfall, which helps manage stormwater runoff costs. The inventoried trees in St. Augustine intercept nearly 6.9 million gallons of rainfall annually (Table 5). On average, the estimated annual savings for the city in stormwater runoff management is $41,296. The average benefit per tree equaled $14.10 per year.



- *Trees reduce stormwater runoff by capturing and storing rainfall in their canopy and releasing water into the atmosphere.*
- *Tree roots and leaf litter create soil conditions that promote the infiltration of rainwater into the soil.*
- *Trees help slow down and temporarily store runoff and reduce pollutants by absorbing nutrients and other pollutants from soils and water through their roots.*
- *Trees transform pollutants into less harmful substances.*

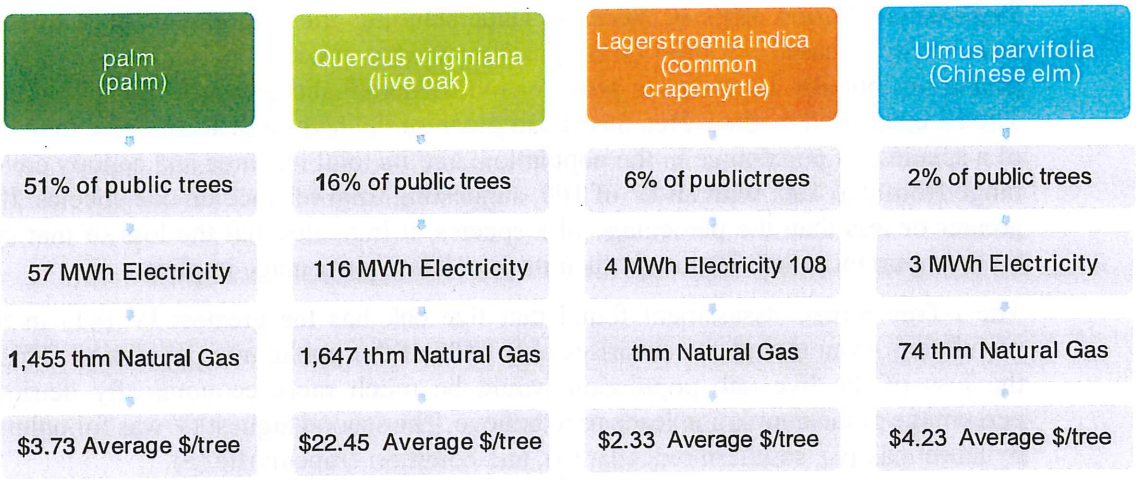
Mature, large-statured trees offered the greatest benefits and provided the most value. Of all species inventoried, *Quercus virginiana* (live oak) contributed most of the annual stormwater benefits. The population of live oak (16% of ROW) intercepted just under 3.8 million gallons of rainfall and the most dominant public tree species, palm (51% of public trees), intercepted approximately $1.4 million gallons of rainfall. The palms' population canopy is approximately 360,000 square feet (average 244 square feet per tree), and the live oaks' population is 820,000 square feet (average 1,704 square feet per tree). The larger live oak population yields a greater benefit. Common crapemyrtle and southern magnolia comprised 6% and 2% of the public tree population, respectively. The southern magnolia absorbed 2 times more gallons of rainfall than common crapemyrtle.

Table 5. Stormwater Benefits Provided by Public Trees

Most Common Trees Collected During Inventory		Number of Trees	Percent of Total Trees	Total Rainfall Interception	Gallons per Tree
Common Name	Botanical Name		(%)	(gal.)	(gal.)
palm	Palm	1,480	51	1,443,345	975
live oak	Quercus virginiana	483	16	3,761,846	7,789
common crapemyrtle	Lagerstroemia indica	165	6	55,700	338
southern redcedar	Juniperus silicicola	106	4	146,715	1,384
laurel oak	Quercus laurifolia	99	3	412,103	4,163
Chinese elm	Ulmus parvifolia	73	2	62,483	856
dahoon	Ilex cassine	49	2	26,388	539
southern magnolia	Magnolia grandiflora	44	2	60,094	1,366
baldcypress	Taxodium distichum	42	1	36,371	866
sugarberry	Celtis laevigata	40	1	89,267	2,232
Chinese privet	Ligustrum japonicum	39	1	14,006	359
American sycamore	Platanus occidentalis	35	1	138,837	3,967
other public trees	~40 species	273	9	635,538	2,328
Total	~52 species	2,928	100	6,882,692	2,351

Energy Benefits. Public trees conserve energy by shading structures and surfaces, which reduces electricity use for air conditioning in the summer. Additionally, trees divert wind in the winter to reduce natural gas use. Based on the inventoried trees, the annual electric and natural gas savings in St. Augustine are equivalent to 245 MWh of electricity and 4,550 therms of natural gas, which accounts for an annual savings of just under $24,000 in energy consumption. The average benefit per tree equaled $7.94 per year.

Palms contributed over $5,500 to the annual energy benefits of the urban forest. Its contribution was mostly due to its dominance on the streets. Other tree species, specifically live oak, white ash, and American and slippery elm, contributed more to reduced energy usage on a per-tree basis. The annual value these trees provide exceeds $20 per tree. Small-statured trees (such as common crapemyrtle) or small trees by relative age (such as Chinese elm) were found to have smaller reductions in energy usage on a per-tree basis, less than $5 per tree.



Air Quality Benefits

Air Quality Benefits. The inventoried tree population annually removes almost 1,800 pounds of air pollutants (including ozone, nitrogen dioxide, sulfur dioxide, and particulate matter) through deposition. The population also avoids 2,800 pounds annually. The i-Tree Streets calculation takes into account the biogenic volatile organic compounds (BVOC's) that are released from trees. The net total value of these benefits is estimated to be $423.

While trees do a great deal to absorb air pollutants, they also contribute negatively to air pollution. Trees emit various BVOCs, such as isoprenes and monoterpenes, which can also contribute to formation of ozone, a harmful gas that pollutes the air and damages vegetation. These BVOC emissions are accounted for in the air quality net benefit. Live oak, all pines, red bottlebrush, and American sweetgum were reported BVOC contributors.

A common example of a natural BVOC is the gas emitted from pine trees, which creates the distinct smell of a pine forest.

The inventoried trees removed or avoided more pollutants than they emitted, resulting in a positive economic value. The trees that provided the most benefits based on an annual per-tree average value were white ash, slippery elm, American elm, and pecan ($6.97, $4.93, $4.06, and $3.19, respectively). i-Tree has calculated that small-statured trees, such as common crapemyrtle and dahoon, provided fairly small benefits, $0.46 and $0.70, respectively. Large-statured trees offered the greatest benefits and provided the most value.

Carbon Sequestration Benefits. Trees sequester CO_2 during growth (Nowak et al. 2013). This prevents CO_2 from reaching the upper atmosphere, where it can react with other compounds and form harmful gases like ozone, which adversely affects air quality. The i-Tree Streets calculation takes into account the carbon emissions that are not released from power stations due to the heating and cooling effect of trees (i.e., conserved energy in buildings and homes). It also calculates emissions released during tree care and maintenance, such as driving to the site and operating equipment. The net carbon benefit is just under $5,000 per year.

The city's public trees sequester 184 tons of carbon. Through avoidance, 167 tons of CO_2 are removed each year. Black locust, white ash, and live oak provided the most carbon benefits, with each tree sequestering an annual per tree average of $7.85, $6.08, and $5.42, respectively, worth of carbon.

Importance Values (IV) of Species. Understanding the importance of a tree species to the community is based not only on its presence on the street ROW and in parks and other public properties, but also its ability to provide environmental and economic benefits to the community. The IV calculated by the i-Tree Street computer model takes into account the total number of trees of a species, its percentage in the population, and its total leaf area and canopy cover. The IV can range from 0 to 100, with an IV of 100, suggesting total reliance on one species. If IV values are greater or less than the percentage of a species, it indicates that the loss of that species may be more important or less important than its population percentage implies.

The i-Tree Streets assessment found that live oak has the greatest IV (41) in the public tree population, even though it comprises only 16% of the public tree population. This indicates that the loss of the live oak population would be much more economically detrimental than its percentage of the population leads us to believe. The second highest IV was for palm (30), followed by laurel oak (6), southern redcedar (3), and common crapemyrtle (3).

These five species—live oak, laurel oak, American sycamore, pecan, and American elm—have IVs greater than their distributions on the ROW. Because they are large growing, the size and canopy of broadleaf species by nature provide more environmental benefits to the community, which all factor into assigning IV. The IV for palms is much less than its percentage of the population, indicating that if palm were lost, its economic impact would not be as significant.

Currently, the aesthetic/other benefits provided by public trees were rated as having the greatest value to the community. The property value increase provided by trees is important to stimulate economic growth. In addition to increasing aesthetics and property values, trees manage stormwater through rainfall interception, provide shade and windbreaks to reduce energy usage, and store and sequester CO_2. Even though these environmental benefits were not found to be as great as the aesthetic/other benefits, they are noteworthy.

i-Tree Streets analysis found that the live oak is St. Augustine's most influential public tree. If this species was lost to an invasive species or disease or other threats, its loss would be felt more than the community may realize.

To increase the benefits the urban forest provides, the city should plant large-statured tree species that manage the most stormwater, absorb the most CO_2, and remove the most air pollutants. Leafy, large-stature trees consistently create the most environmental and economic benefits, and is discussed further in Recommendation 7.

WHAT WE WANT – DEVELOPING A UNIFIED VISION

To ensure that the work on this plan and resulting recommendations were comprehensive and representative of the community's needs and priorities, efforts were undertaken to gain information and insights from a variety of stakeholders in St. Augustine. Primarily, these efforts included:

1. ***Public Roundtable and City Commission Meetings.*** An Urban Forestry Management Plan Roundtable was attended by city staff, Street Tree Advisory Committee members, and local stakeholders, such as the University of Florida, St. Augustine Neighborhood Council, St. Augustine Livability & Sustainability Alliance, Keep Riberia Pointe Green, and the general public. The facilitated discussion focused on the preliminary findings from the public tree inventory, urban tree canopy study, and tree benefit calculations. The three categories that indicate a sustainable urban forest program (trees, players, management approach) were also discussed (see Appendix E. for the minutes of the Public Roundtable). A presentation of the preliminary urban forest data was also presented to a regular meeting of the City Commission.

2. ***Public Survey.*** A survey to gauge the level of support for and knowledge of the urban forest and city's urban forest management program was created and distributed online through various channels by the city. A total of 193 respondents answered 14 survey questions which asked questions about the city's urban forest management program, community values about trees, and priority action items related to trees.

3. ***Municipal Staff Interviews on Management Practices/Budgets.*** City staff provide a significant amount of data and input on current practices and challenges. The in-person interviews were conducted with staff from many departments, including Public Works, Development Services, Code Enforcement, Environmental Compliance, and Public Affairs.

Public Roundtable Discussion on Urban Forest and Program Sustainability

Informed by the recent inventory and UTC data, and using local knowledge and experiences, the participants of the Public Roundtable were asked for their opinions and perceptions of St. Augustine's urban forest and the management program. Specifically, participants broadly rated components of three categories that are indicators of a sustainable community forest:

- *The Trees* category include indicators related to the status of the tree resource itself, including knowledge of that resource.
- *The Players* category evaluates the necessary involvement and collaboration of stakeholders at all levels.
- *The Management Approach* category evaluates availability and use of different tools and/or actions to improve and sustain the urban forest resource.

The consensus results from this informal discussion are presented in Table 6.

Table 6. Summary of the Public Roundtable Sustainability Discussion

Indicators of a Sustainable Community Forest		Assessed Conditions or Performance		
		Low	Moderate	Good
The Trees	Urban Tree Canopy Level (All Trees)		■	
	Canopy Location/Distribution (All Trees)		■	
	Condition (Public Trees)		■	
	Size/Age Distribution (Public Trees)			■
	Species Diversity (Public Trees)		■	
	Species Suitability (Public Trees)		■	
The Players	Public Awareness	■		
	City Department/Agency Cooperation		■	
	Neighborhood Action		■	
	Large Private Landholder Involvement	■		
	Utility Engagement	■		
	Green Industry Involvement	■		
	Regional Collaboration	■		
	Funder Engagement	■		
The Management Approach	Tree Inventory Data		■	
	Overall Canopy Data		■	
	Management Plan	■		
	Risk Management Program		■	
	Maintenance Program – Public Trees		■	
	Planting Program	■		
	Tree Protection Policy		■	
	City Staffing & Equipment		■	
	Funding	■		
	Totals	9	13	1

THE TREES: Moderate Performance Rating

St. Augustine's 24% tree canopy is average for the region. The public trees are generally in good condition, and diversity of species is high. As only one indicator received a Good performance rating, improvements are recommended; and suggestions were made to improve the overall condition of public trees; identify and protect "historic trees"; remove/control invasive species; and increase planting of large stature trees.

THE PLAYERS: Low Performance Rating

Very few groups in the community are actively involved in urban forestry activities, and most urban forestry efforts are initiated and funded by the city. There is little involvement from large landholders, community groups, schools, potential new funders, or regional partners. Partnerships are a currently an untapped opportunity for St. Augustine. As most of the indicators in this category received a Low performance rating, improvements are strongly recommended. Suggestions were made to increase public education; leverage corporate involvement and support; increase partnerships with schools; engage tour companies; and partner with other civic groups.

THE MANAGEMENT APPROACH: Moderate Performance Rating

The city is well situated for effective management thanks to the breadth of data resources available to make defensible, data-driven management decisions. However, no risk or disaster management plans are in place, and funding is inadequate for a proactive urban forestry program. Policy is in place for protection of private trees during development, but without effective penalties in place. Implementation of this management plan would help the city make great strides towards achieving an improved performance rating.

Citizen Input on St. Augustine's Urban Forest and Management Program

Since the greatest percentage of St. Augustine's overall urban tree canopy is actually in private ownership, and since even 'public trees' belong to the citizens, exploring the results of the public survey provides interesting insights into the management of the current and future forest in St. Augustine.

The survey was made broadly available to citizens and had very good participation, but it was not a formal survey and the number of respondents represent a very low percentage of the city's total population. However, general observations can be made to gauge community sentiment about St. Augustine's tree canopy, the city's urban forest management program, and new projects and initiatives. General survey results and representative comments are presented in Table 7.

Survey Results

When asked for positive or negative opinions on the benefits trees provide the city, the overwhelming response from the community was that the urban forest contributes significant benefits that outweigh the costs of planting and maintenance. 93% of respondents believed that trees define the character of St. Augustine, improve the quality of life, and enhance tourism and city attractions.

Respondents were able to express how they valued the urban forest in general and in relation to other city assets, as well as provide opinions and comments about the city's urban forest management responsibilities. The results showed that citizens highly value the city's tree canopy.

Table 7. Survey Results for Citizen Values of the Urban Forest

Values	Agree	Neutral	Disagree
City Infrastructure			
The condition of the urban forest is less important to me than other public infrastructure needs like sewers and roads	10%	20%	70%
Urban forests are of equal value as other city assets	80%	10%	10%
Trees should not be planted because they cause problems with underground and overhead utilities, street lights, and signs	3%	5%	92%
Economic Development			
Trees are a problem because they conflict with land development	3%	5%	92%
Trees should not be planted in business districts because they block signs and create debris	6%	7%	87%
The city should install pavers or grates around trees to improve walkability	43%	42%	15%
It's fair to require developers to preserve trees in residential and commercial projects	94%	0%	6%
The city should regulate tree removal on private property	64%	23%	13%

Ranking of Public Tree Issues

The city performs a variety of services to manage the public trees on streets, parks, and other public properties. In the opinion of, and as ranked by, the citizens, the most important issues and/or needs related to city-managed trees are:

#1 – Historic tree preservation

#2 – More tree planting

#3 – More/better tree maintenance

#4 – Better communication with citizens about the urban forest and activities of the program

#5 – Street and sidewalk clearance

#6 – Decreasing risk from public trees

General opinions about the city's urban forest management program and specific management efforts are:

Table 8. Survey Results of Citizen Opinions of the Urban Forest Management Program

Urban Forest Management Program	Agree	Neutral	Disagree
I would support additional city funding for maintaining and planting public trees	81%	11%	8%
The city has no need or responsibility to maintain an urban forest	5%	4%	91%
Historic and mature trees should be maintained at almost any cost	75%	14%	11%
The city should remove trees on streets when they become safety problems	55%	30%	15%
City trees need a higher level of maintenance	37%	38%	25%
More trees should be planted on public property	83%	10%	7%
The city is responsive when I report a problem or make a request related to trees	19%	71%	10%

Over 90% of respondents want tax dollars to support public tree planting and maintenance and a professional urban forestry program. But when asked if they think St. Augustine's urban forestry program, staff, and practices are effective, the results were:

Yes – 17%

Needs improvement – 20%

No – 4%

I did not know the city had an urban forestry program – 59%

The salient message is that currently the majority of citizens do not know that the city has a formal urban forest management program.

Citizens Want Action

The survey asked respondents to prioritize seven action items that individually, or as a whole, would elevate St. Augustine's urban forest management program to a more progressive and proactive program. The results are:

Table 9. Survey Results of Citizen Priorities for Urban Forest Management Actions

Rank	Urban Forest Management Action Item
1	Create a master tree planting plan and plant more trees on public property
2	Review, update, and strengthen city regulations for tree care, planting, and preservation on private residential and commercial properties, and for land development projects
3	Review, update, and strengthen city regulations and guidelines for tree care, planting, and preservation on public property
4	Increase awareness in citizens and businesses of the value of St. Augustine's urban forest and urban forest management program
5	Increase and improve maintenance (pruning, removal, mulching, fertilizing, etc.) on all public trees
6	Increase the staff, equipment, and funding resources of the urban forest management program so more work can be done
7	Provide educational opportunities and resources about proper tree care and planting to residents and business owners

Public Input and Comment Summary

Several important themes emerged from the survey, and examples of citizen comments are listed under each theme.

- ***Trees are valuable to the City of St. Augustine.*** Respondents overwhelmingly held high value for the trees in St. Augustine and easily identified many benefits provided by a robust tree canopy.

"Trees are incredibly important, almost as much as any other single community asset."
"Our ancient trees are just as important to tourism as our ancient buildings. Promote and protect them as a true treasure for all."
"Many of our streets are too hot to be walkable without tree shade. Trees slow rainfall, reduce wind, and help mitigate spot-flooding and erosion."
"Trees provide shade, beauty, air quality, wildlife and bird habitat, color, aura, and historic legacies."

- ***Citizens recognize that St. Augustine's trees need support.*** Respondents indicated that to have a healthy urban forest, many factors need to be managed, such as taking care of and replacing aging trees; planting the right tree in the right location; and educating the citizens about the care of trees.

"Our trees need better regular maintenance to prune and guide healthy growth."
"Emphasize tree diversity in our forest and use native trees. Also, give incentives for removing invasive species."
"Educate citizens, businesses, and public utilities on proper tree maintenance and pruning methods, as well as the value of our tree canopies."
"Create a 'St. Augustine Tree Foundation' that encourages protection and enhancement of our urban tree canopy, and provides an ongoing public awareness campaign. Develop a special tour to see the Ancient City's Ancient Trees."
"Include public school education and involvement regarding our urban forests."

- ***Citizens want to see improvements in the city's urban forest management policies and practices.*** In several of the questions, respondents expressed frustration at the ability of private citizens, developers, and utility companies to make decisions to radically trim and/or cut down trees. Others felt that private citizens should have freedom to decide about the trees on their property.

"Builders and developers should have a list of expectations for contributing to the health of the city's urban forest."
"Continue to ask for community involvement; educating us on what the city wants to do with the urban forestry program."
"Public/private partnerships should be developed to encourage more tree planting and on-going care of our trees."

Concluding Thoughts on the Survey Results

There is great support from the public for trees. Citizens appear to be willing champions for the urban forest management program. The bottom line is that St. Augustine's citizens love the trees in their city. In the survey, they repeatedly indicated that the trees help define the city, make it a more inviting place to live, provide many health benefits to residents, and create a positive environment for wildlife. Respondents especially seemed attached to the large, mature trees found in many neighborhoods and parks, which indicates the importance of ongoing planting for the benefit of future generations.

More marketing/communications is needed to inform more people. The survey indicated that most participants were not aware that St. Augustine was a Tree City, USA or that it has an urban forestry program. Community leaders should strive to use information from the inventory and the management plan to create educational and marketing campaigns using the city's website, e-mail listserv, Twitter, and Facebook. In addition, the city should leverage neighborhood, business, and non-profit organizations' communication systems to reach out to the public with important messages.

City policies and procedures could help support the urban forest and management program over the long term. In the open response sections of the survey, many respondents commented on the ability of individual citizens and developers to make their own decisions about cutting down trees without seeming to suffer any negative consequences. The majority of those comments indicated a desire to have strong tree ordinances and development codes and/or the city resources to enforce the ordinances that are already in place.

"St. Augustine should create a legacy event of recording and acknowledging the growth and accomplishments of our urban forestry efforts. St. Augustine should not only be a 'City of Lights' but a 'City of Trees.' That can be our message of preservation to future generations.

It's not about us; it's about our children's children.

Trees are our messengers."

Anonymous comment from public survey

HOW DO WE GET THERE? NEXT STEPS AND RECOMMENDATIONS

The Objective of Urban Forest Management

To optimize the leaf area of the entire urban forest by establishing and maintaining a canopy of genetically appropriate (adapted & diverse) trees and shrubs with minimum risk to the public and in a cost-effective manner. - Dr. W. A. Kenney, University of Toronto

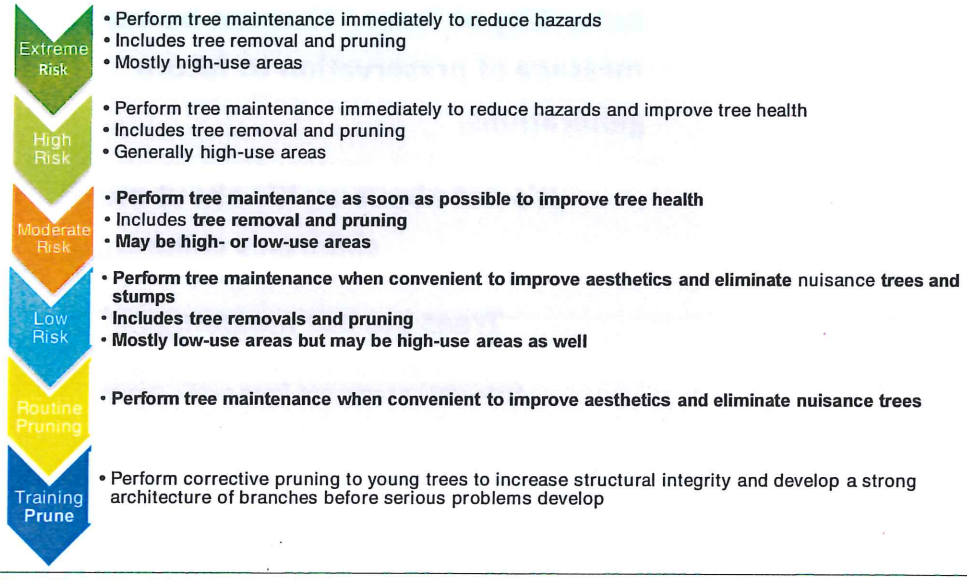
The City of St. Augustine now has comprehensive data regarding its public trees and citywide tree canopy coupled with thoughtful input and insight from its citizens, staff, and local leaders. All stakeholders expressed a desire for the urban forest to be expanded, protected, and promoted in an efficient manner, and for its benefits to be maximized for the enjoyment of all citizens. The city has direct control over public trees and has indirect influence on private trees. Using its expertise and guidance from the data, the following are action steps with specific recommendations for the city to formalize a proactive urban forest management program.

The American Public Works Association (APWA) recognizes the importance of public trees and the value of this green infrastructure component in cities. APWA maintains guidance position statements recommending that public works professionals follow certain practices, methods, and activities, and has issued one for "Quality Management of the Urban Forest" (see Appendix G for implementing these action steps which accomplish many of the APWA's recommendations).

Action Step 1: Perform Priority and Proactive Maintenance

A five-year maintenance program has been developed for St. Augustine and is based on the public tree inventory data. The program is designed to reduce risk through prioritized tree removal and pruning, and to improve tree health and structure through proactive pruning cycles.

While implementing a tree care program is an ongoing process, tree work must always be prioritized to reduce public safety risks. It is recommended that the city complete the work identified during the inventory based on the assigned risk rating; however, routinely monitoring the tree population is essential so that other Extreme or High Risk trees can be identified and systematically addressed. While regular pruning cycles and tree planting are important, priority work (especially for Extreme or High Risk trees) must sometimes take precedence to ensure that risk is expediently managed.



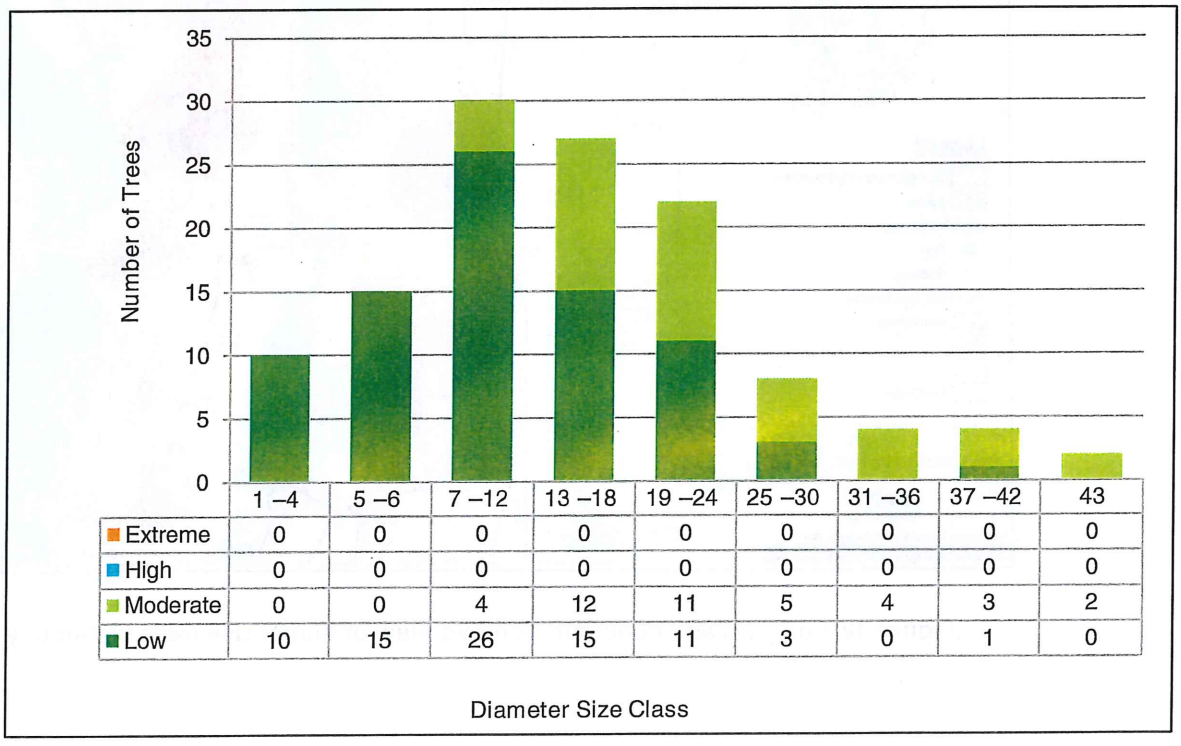
The recommended tree maintenance work is divided into either priority or proactive maintenance. Priority maintenance includes tree removals and pruning of trees with an assessed risk rating of Moderate, High, and Extreme risk. Proactive tree maintenance includes pruning of trees with an assessed risk of Low risk and trees that are young. Tree planting, inspections, and community outreach are also considered proactive maintenance.

Priority Tree Removal

Although tree removal is usually considered a last resort and may sometimes create a negative reaction from the community, there are circumstances in which removal is necessary. Trees fail from natural causes, such as diseases, insects, and weather conditions, and from physical injury due to vehicles, vandalism, and root disturbances. Trees should be removed when corrective pruning will not adequately eliminate the hazard or when correcting problems would be cost-prohibitive. Trees that cause obstructions or interfere with power lines or other infrastructure should be removed when their defects cannot be corrected through pruning or other maintenance practices. Diseased, invasive, and nuisance trees also warrant removal.

Even though large, short-term expenditures may be required, it is important to secure the funding needed to complete priority tree removals. Expedient removal reduces risk and promotes public safety.

Figure 11 presents tree removals by risk rating and diameter size class. The following sections briefly summarize the recommended removals identified during the inventory.



	1 –4	5 –6	7 –12	13 –18	19 –24	25 –30	31 –36	37 –42	43
Extreme	0	0	0	0	0	0	0	0	0
High	0	0	0	0	0	0	0	0	0
Moderate	0	0	4	12	11	5	4	3	2
Low	10	15	26	15	11	3	0	1	0

Figure 11. Tree removals by risk rating and diameter size class.

The inventory identified 0 Extreme Risk trees, 0 High Risk trees, 41 Moderate Risk trees, and 81 Low Risk trees that are recommended for removal.

The diameter size classes for Moderate Risk trees ranged between 7 and 12 inches diameter at breast height (DBH) and greater than 43 inches DBH. These trees should be removed within the next year based on their assigned risk.

Low Risk removals pose less of a threat; these trees are generally small, dead, invasive, or poorly formed trees that need to be removed. Eliminating these trees will reduce breeding site locations for insects and diseases and will increase the aesthetic value of the area. Healthy trees growing in poor locations or undesirable species are also included in this category. All Low Risk trees should be removed when convenient and after all High and Moderate Risk removals and pruning have been completed.

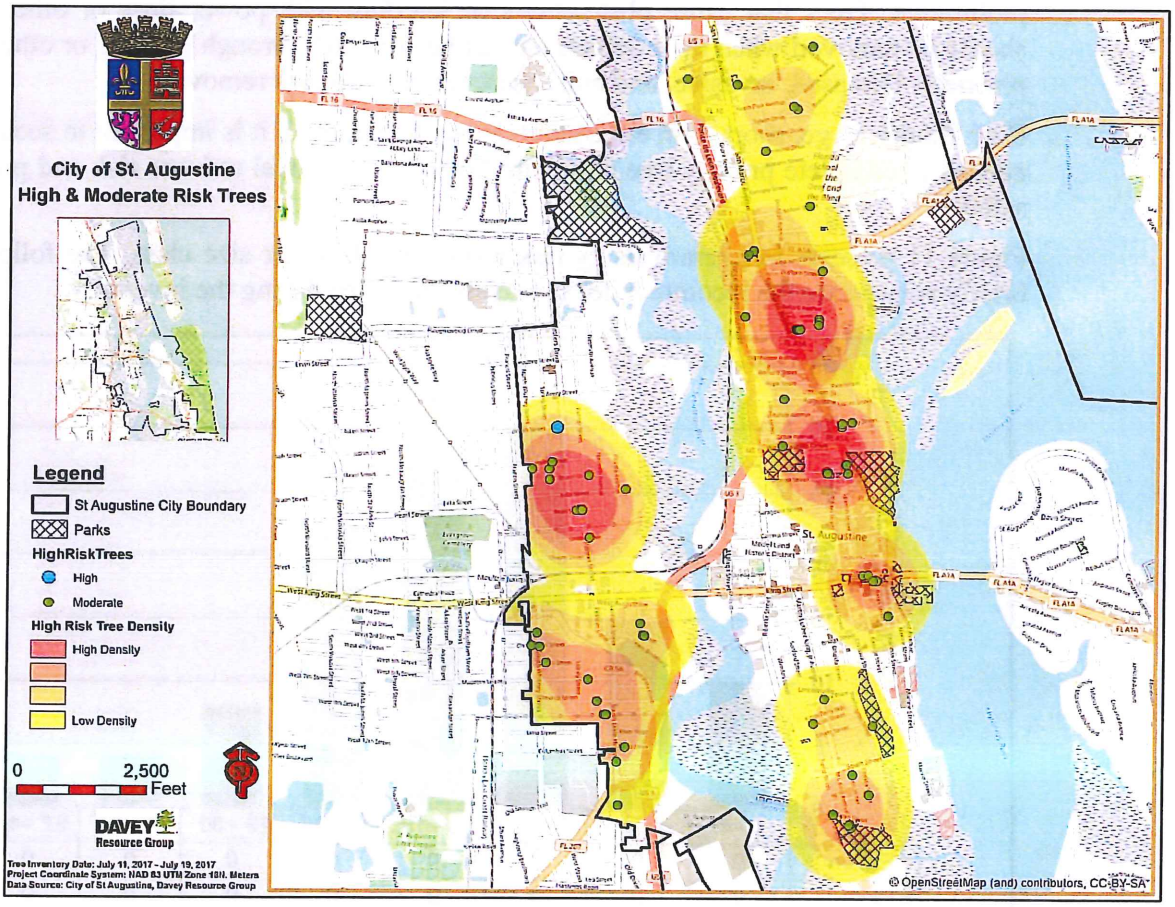


Figure 12. Location and concentration overview of higher risk trees within city limits.

Recommendation 1: Address immediate removals

Remove trees indicated by the inventory and, unless already scheduled for removal, trees noted as being in poor condition should be inspected on a regular basis. Corrective action should be taken when warranted. If their condition worsens, tree removal may be required. Proactive tree maintenance that actively mitigates elevated-risk situations will promote public safety.

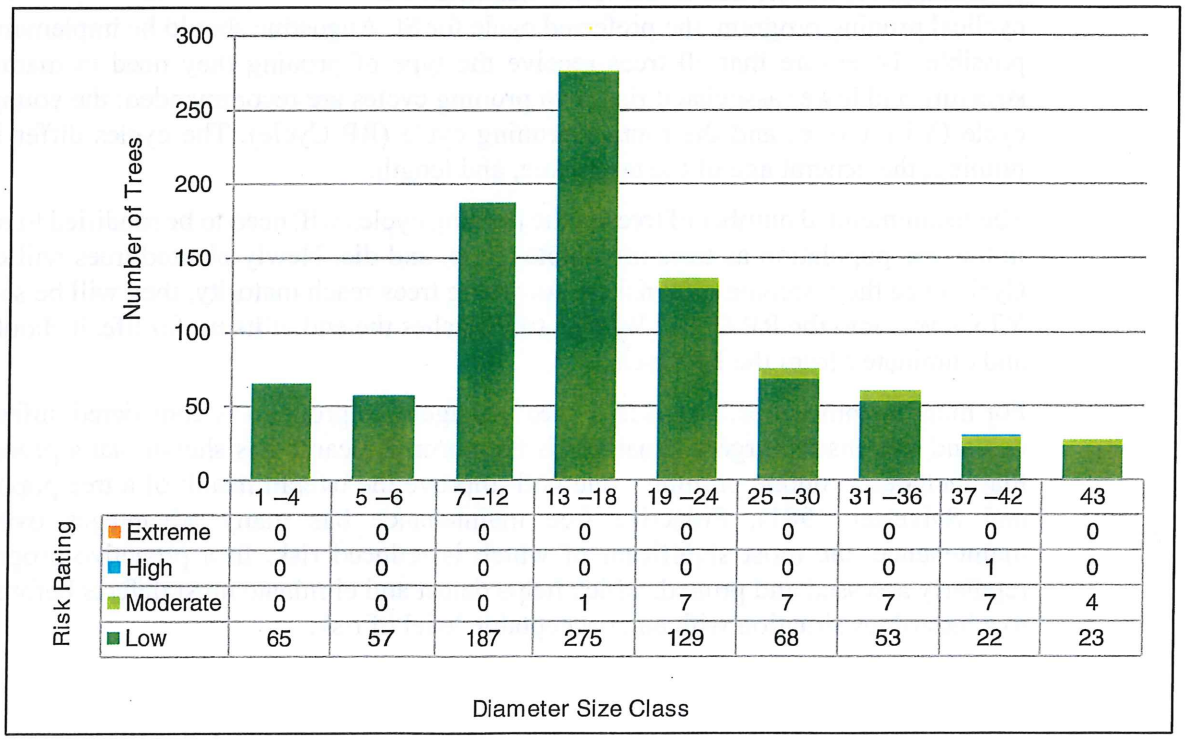
Recommendation 2: Update inventory on a regular basis

Update the tree inventory database regularly. Updating data can streamline workload management and lend insight into setting accurate budgets and staffing levels. Inventory updates should be made electronically and can be implemented using TreeKeeper® 8 or similar inventory data management computer software program.

Priority Tree Pruning

Pruning generally requires cleaning the canopy of both small and large trees to remove defects such as dead and/or broken branches that may be present even when the rest of the tree is sound. In these cases, pruning the branch or branches can correct the problem and reduce risk associated with the tree.

Figure 13 presents tree pruning by risk rating and diameter size class. The following sections briefly summarize the pruning recommendations identified during the inventory.



Risk Rating	1 –4	5 –6	7 –12	13 –18	19 –24	25 –30	31 –36	37 –42	43
Extreme	0	0	0	0	0	0	0	0	0
High	0	0	0	0	0	0	0	1	0
Moderate	0	0	0	1	7	7	7	7	4
Low	65	57	187	275	129	68	53	22	23

Figure 13. Tree pruning by risk rating and diameter size class.

The inventory identified 0 Extreme Risk trees, 1 High Risk tree, and 33 Moderate Risk trees recommended for pruning. High Risk and Moderate Risk trees ranged in diameter size classes from 13–18 inches DBH to 43 inches DBH and greater.

Recommendation 3: Perform tree pruning/removal on trees identified as Extreme and High Risk in the first year

Moderate and Low Risk trees recommended for pruning or removal should be included in a proactive, routine maintenance cycle after all the higher risk trees are addressed.

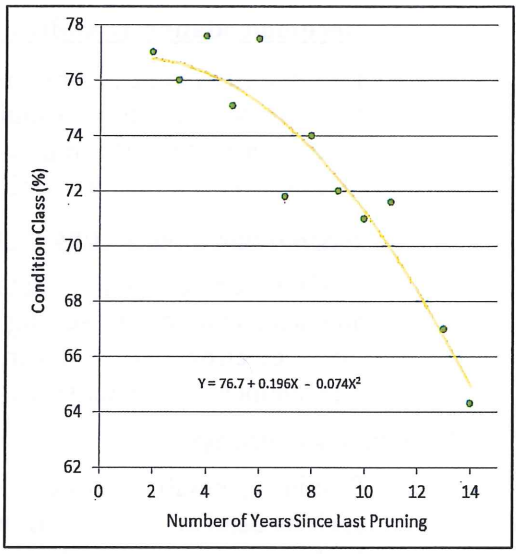


Figure 14. Relationship between average tree condition class and the number of years since the most recent pruning (adapted from Miller and Sylvester 1981).

Pruning Cycles Discussion

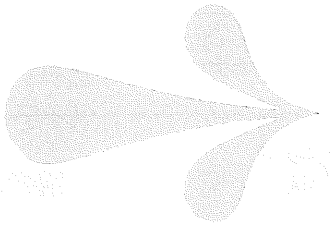
The goals of pruning cycles are to visit, assess, and prune trees on a regular schedule to improve health and reduce risk. It is recommended that routine pruning cycles begin after all Extreme, High, and Moderate Risk trees are corrected through removal or pruning. However, due to the many benefits of a cyclical pruning program, the preferred cycle for St. Augustine should be implemented as soon as possible. To ensure that all trees receive the type of pruning they need to mature with better structure and lower associated risk, two pruning cycles are recommended: the young tree training cycle (YTT Cycle) and the routine pruning cycle (RP Cycle). The cycles differ in the type of pruning, the general age of the target tree, and length.

The recommended number of trees in the pruning cycles will need to be modified to reflect changes in the tree population as trees are planted, age, and die. Newly planted trees will enter the YTT Cycle once they become established. As young trees reach maturity, they will be shifted from the YTT Cycle into the RP Cycle. When a tree reaches the end of its useful life, it should be removed and eliminated from the RP Cycle.

For many communities, a proactive tree management program is considered unfeasible. An on-demand response to urgent situations is the norm. Research has shown that a proactive program that includes a routine pruning cycle will improve the overall health of a tree population (Miller and Sylvester 1981). Proactive tree maintenance has many advantages over on-demand maintenance, the most significant of which is reduced risk. In a proactive program, trees are regularly assessed and pruned, which helps detect and eliminate most defects before they escalate to a hazardous situation with an unacceptable level of risk.

Other advantages of a proactive program include: increased environmental and economic benefits from trees, more predictable budgets and projectable workloads, and reduced long-term tree maintenance costs.

Why Prune Trees on a Cycle?



Miller and Sylvester (1981) examined the frequency of pruning for 40,000 street and boulevard trees in Milwaukee, Wisconsin. They documented a decline in tree health as the length of the pruning cycle increased. When pruning was not completed for more than 10 years, the average tree condition was rated 10% lower than when trees had been pruned within the last several years. Miller and Sylvester suggested that a pruning cycle of five years is optimal for urban trees.

Young Tree Training Cycle

Trees included in the YTT Cycle are generally less than 8 inches DBH. These younger trees sometimes have branch structures that can lead to potential problems as the tree ages. Potential structural problems include codominant leaders, multiple limbs attaching at the same point on the trunk, or crossing/interfering limbs. If these problems are not corrected, they may worsen as the tree grows, increasing risk and creating potential liability.

YTT pruning is performed to improve tree form or structure; the recommended length of a YTT Cycle is three years because young trees tend to grow at faster rates (on average) than more mature trees.

The YTT Cycle differs from the RP Cycle in that these trees generally can be pruned from the ground with a pole pruner or pruning shear. The objective is to increase structural integrity by pruning for one dominant leader. YTT Pruning is species-specific, since many trees such as *Lagerstroemia indica* (crapemyrtle) may naturally have more than one leader. For such trees, YTT pruning is performed to develop a strong structural architecture of branches so that future growth will lead to a healthy, structurally sound tree.

Recommendation 4: Implement a three-year YTT Cycle to begin after all High and Moderate Risk trees are removed or pruned

The YTT Cycle will include existing young trees. During the inventory, 369 trees smaller than 7 inches DBH were inventoried and recommended for young tree training. Since the number of existing young trees is relatively small, and the benefit of beginning the YTT Cycle is substantial, DRG recommends that an average of 138 trees be structurally pruned each year over 3 years, beginning in Year One of the management program.

If trees are planted, they will need to enter the YTT Cycle after establishment, typically a few years after planting. In future years, the number of trees in the YTT Cycle will be based on tree planting efforts and growth rates of young trees. St Augustine should strive to prune approximately one-third of its young trees each year.

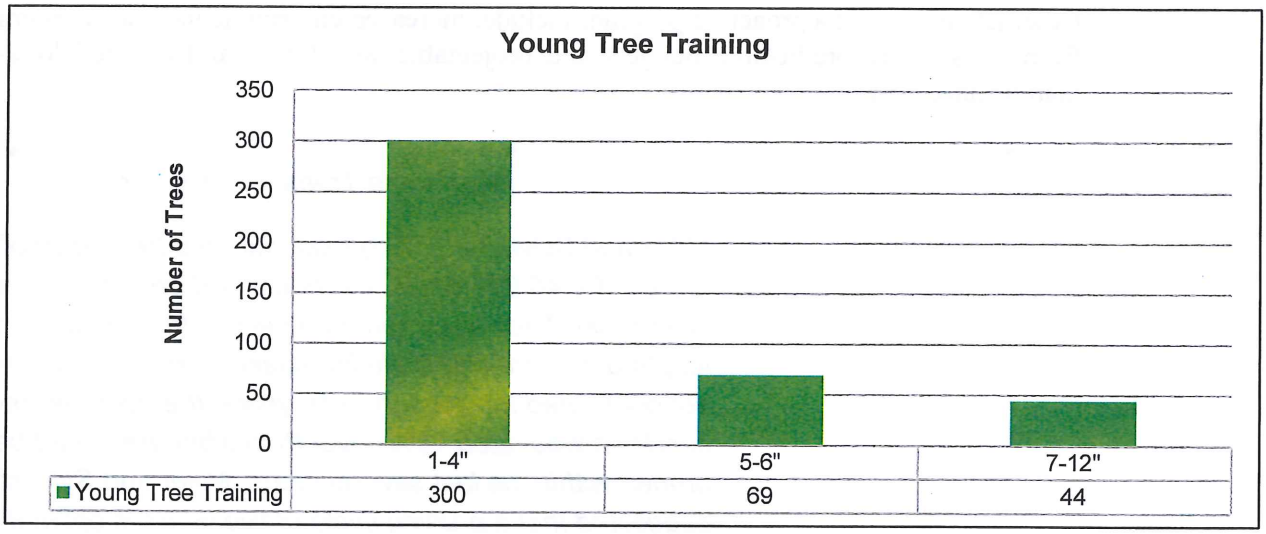


Figure 15. Trees recommended for the YTT Cycle by diameter size class.

Routine Pruning Cycle

The RP Cycle includes established, maturing, and mature trees (mostly greater than 7 inches DBH) that need cleaning, crown raising, and reducing to remove deadwood and improve structure. Over time, routine pruning can reduce reactive maintenance, minimize instances of elevated risk, and provide the basis for a more defensible risk management program. Included in this cycle are Low Risk trees that require pruning and pose some risk but have a smaller size of defect and/or less potential for target impact. The defects found within these trees can usually be remediated during the RP Cycle.

The length of the RP Cycle is based on the size of the tree population and what was assumed to be a reasonable number of trees for a program to prune per year. Generally, the RP Cycle recommended for a tree population is five years but may extend to seven years if the population is large.

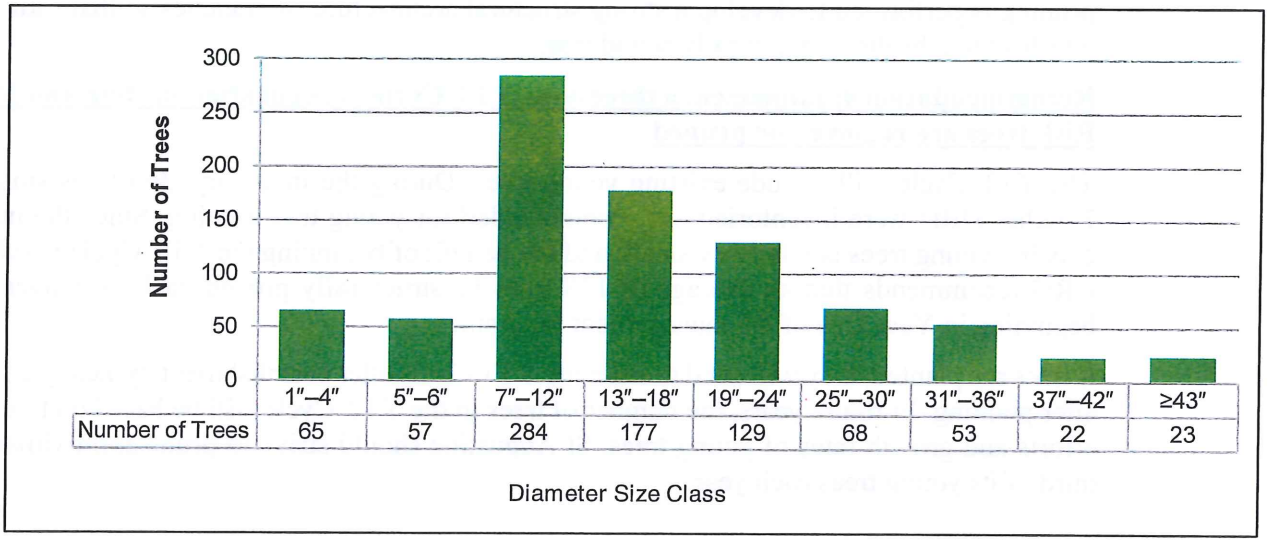


Figure 16. Trees recommended for the RP Cycle by diameter size class.

Recommendation 5: Establish a five-year RP Cycle in which approximately one-fifth of the tree population is to be pruned each year

The 2017 tree inventory identified approximately 880 trees that should be pruned over a five-year RP Cycle. An average of 176 trees should be pruned each year over the course of the cycle. DRG recommends that the RP Cycle begin in Year Two of this five-year plan, after all Extreme and High Risk trees are pruned. The inventory found that most trees (76%) on the street ROW needed routine pruning. Figure 16 shows that a variety of tree sizes will require pruning; however, most of the trees that require routine pruning were smaller than 24 inches DBH.

Maintenance Schedule

Utilizing data from the 2017 St Augustine tree inventory, an annual maintenance schedule was developed that details the number and type of tasks recommended for completion each year. DRG made budget projections using industry knowledge and public bid tabulations. Actual costs were not specified by St. Augustine. A complete table of estimated costs for St. Augustine's five-year tree management program is presented in Table 10.

The schedule provides a framework for completing the inventory maintenance recommendations over the next five years. Following this schedule can shift tree care activities from an on-demand system to a more proactive tree care program.

Proactive tree maintenance has many advantages over reactive maintenance, the most significant of which is reduced risk to the public. Proactive systems ultimately reduce crisis situations in the urban forest because every public tree is visited, assessed, and maintained on a regular basis. Other benefits include more predictable budgets and projectable workloads, reduced long-term tree maintenance costs, and increased environmental and economic benefits from trees as more reach maturity.

Recommendation 6: Ensure that the city's tree maintenance budget is no less than $38,000 annually

To implement the proactive maintenance schedule, the St. Augustine's tree maintenance budget should be no less than $38,000 annually as shown in Table 10. Annual budget funds are needed to ensure that extreme and high risk trees are remediated and that crucial YTT and RP Cycles can begin. With proper professional tree care, the safety, health, and beauty of the urban forest will improve.

If routing efficiencies and/or contract specifications allow for the completion of more tree work, or if the schedule requires modification to meet budgetary or other needs, then the schedule should be modified accordingly. Unforeseen situations such as severe weather events may arise and change the maintenance needs of trees. Should conditions or maintenance needs change, budgets and equipment will need to be adjusted to meet the new demands.

Table 10. Estimated Costs for Five-Year Tree Maintenance Program

Estimated Costs for Each Activity			Year 1		Year 2		Year 3		Year 4		Year 5		Five-Year Cost
Activity	Diameter	Cost/Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
Severe and High Risk Removals	1-3"	$28	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$58	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$138	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	13-18"	$314	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	19-24"	$605	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	25-30"	$825	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	31-36"	$1,045	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	37-42"	$1,485	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	43"+	$2,035	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			0	$0	0	$0	0	$0	0	$0	0	$0	$0
Moderate and Low Risk Removals	1-4"	$28	2	$55	2	$55	2	$55	2	$55	2	$55	$275
	5-6"	$58	0	$0	3	$173	4	$230	4	$230	4	$230	$863
	7-12"	$138	5	$688	6	$825	6	$825	6	$825	7	$963	$4,125
	13-18"	$314	7	$2,195	5	$1,568	5	$1,568	5	$1,568	5	$1,568	$8,465
	19-24"	$605	8	$4,840	3	$1,815	4	$2,420	4	$2,420	3	$1,815	$13,310
	25-30"	$825	4	$3,300	1	$825	1	$825	1	$825	1	$825	$6,600
	31-36"	$1,045	1	$1,045	0	$0	1	$1,045	1	$1,045	1	$1,045	$4,180
	37-42"	$1,485	3	$4,455	1	$1,485	0	$0	0	$0	0	$0	$5,940
	43"+	$2,035	2	$4,070	0	$0	0	$0	0	$0	0	$0	$4,070
Activity Total(s)			32	$20,647	21	$6,745	23	$6,968	23	$6,968	23	$6,500	$47,827
Stump Removals	1-4"	$18	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	5-6"	$28	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$44	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	13-18"	$72	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	19-24"	$94	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	25-30"	$110	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	31-36"	$138	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	37-42"	$160	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	43"+	$182	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			0	$0	0	$0	0	$0	0	$0	0	$0	$0
High and Moderate Risk Pruning	1-4"	$20	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	5-6"	$30	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$75	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	13-18"	$120	1	$120	0	$0	0	$0	0	$0	0	$0	$120
	19-24"	$170	7	$1,190	0	$0	0	$0	0	$0	0	$0	$1,190
	25-30"	$225	7	$1,575	0	$0	0	$0	0	$0	0	$0	$1,575
	31-36"	$305	7	$2,135	0	$0	0	$0	0	$0	0	$0	$2,135
	37-42"	$380	8	$3,040	0	$0	0	$0	0	$0	0	$0	$3,040
	43"+	$590	4	$2,360	0	$0	0	$0	0	$0	0	$0	$2,360
Activity Total(s)			34	$10,420	0	$0	0	$0	0	$0	0	$0	$10,420
Routine Pruning (5-year cycle)	1-4"	$20	0	$0	13	$260	13	$260	13	$260	13	$260	$1,040
	5-6"	$30	0	$0	11	$342	11	$342	11	$342	11	$342	$1,368
	7-12"	$75	0	$0	57	$4,260	57	$4,260	57	$4,260	57	$4,260	$17,040
	13-18"	$120	0	$0	35	$4,248	35	$4,248	35	$4,248	35	$4,248	$16,992
	19-24"	$170	0	$0	26	$4,386	26	$4,386	26	$4,386	26	$4,386	$17,544
	25-30"	$225	0	$0	14	$3,060	14	$3,060	14	$3,060	14	$3,060	$12,240
	31-36"	$305	0	$0	11	$3,233	11	$3,233	11	$3,233	11	$3,233	$12,932
	37-42"	$380	0	$0	4	$1,672	4	$1,672	4	$1,672	4	$1,672	$6,688
	43"+	$590	0	$0	5	$2,714	5	$2,714	5	$2,714	5	$2,714	$10,856
Activity Total(s)			0	$0	176	$24,175	176	$24,175	176	$24,175	176	$24,175	$96,700
Young Tree Training Pruning (3-year cycle)	1-4"	$20	100	$2,000	100	$2,000	100	$2,000	100	$2,000	100	$2,000	$10,000
	5-8"	$30	39	$1,170	38	$1,140	38	$1,140	38	$1,140	38	$1,140	$5,730
Activity Total(s)			139	$3,170	138	$3,140	138	$3,140	138	$3,140	138	$3,140	$15,730
Replacement Tree Planting	Purchasing	$170	8	$1,360	8	$1,360	8	$1,360	8	$1,360	8	$1,360	$6,800
	Planting	$110	8	$880	8	$880	8	$880	8	$880	8	$880	$4,400
Activity Total(s)			16	$2,240	16	$2,240	16	$2,240	16	$2,240	16	$2,240	$11,200
Replacement Young Tree Maintenance	Mulching	$100	8	$800	8	$800	8	$800	8	$800	8	$800	$4,000
	Watering	$100	8	$800	8	$800	8	$800	8	$800	8	$800	$4,000
Activity Total(s)			16	$1,600	16	$1,600	16	$1,600	16	$1,600	16	$1,600	$8,000
Activity Grand Total			221		351		353		353		353		1,629
Cost Grand Total				$38,077		$37,900		$38,123		$38,123		$37,655	$189,877

Action Step 2: Practice Purposeful Planting

The inventory found only 40 vacant planting sites on public streets, but more opportunities for tree planting on public lands likely exist in areas such as state rights-of-way, parks, schools and university properties, and around municipal and other government-owned facilities. When planning tree planting projects, the guiding principles for tree species and site selection should be "right tree in the right place," species diversity, and maximizing the ecosystem services provided by particular trees in St. Augustine. Appendix F presents maps of potential planting sites in the city.

Recommendation 7: Avoid planting additional live oak and palm species on public properties

In the short term, the city should avoid planting any additional live oak or palm since these two species already make up 70% of the public urban forest. Instead, other species can be planted to improve diversity and provide specific desired benefits to the city. As trees are removed and additional planting sites are identified, the following list of large-statured tree species and their primary benefit/services is recommended for the city to consider when ample growing space is available. These species should also be promoted to land developers and private property owners where there is more likely adequate space to grow these trees to maturity.

Pollutant Removal

- *Ulmus americana* (American elm)
- *Liriodendron tulipifera* (tuliptree)
- *Tilia americana* (American linden)
- *Celtis laevigata* (sugarberry)
- *Cedrus deodara* (deodar cedar)

Carbon Storage

- *Quercus falcata* (southern red oak)
- *Quercus shumardii* (shumard oak)
- *Platanus occidentalis* (American sycamore)
- *Ulmus americana* (American elm)
- *Liriodendron tulipifera* (tuliptree)

Stormwater Reduction

- *Liriodendron tulipifera* (tuliptree)
- *Ulmus americana* (American elm)
- *Magnolia grandiflora* (southern magnolia)
- *Tilia americana* (American linden)
- *Platanus occidentalis* (American sycamore)

Energy Reduction

- *Liriodendron tulipifera (tuliptree)*
- *Ulmus americana (American elm)*
- *Platanus occidentalis (American sycamore)*
- *Tilia americana (American linden)*
- *Magnolia grandiflora* (southern magnolia)

Recommendation 8: Create a Master Tree Planting Plan for the city

As the stakeholders clearly expressed, a priority for St. Augustine is to create a master tree planting plan for the public, and potentially even private property. The city now has access to a vast amount of GIS mapping and other geospatial data to create a practical planting plan. Using tree inventory data, land cover data, underground and aerial utility locations, and right-of-way information, the city could identify all potential planting areas on public lands. Using similar information for commercial and institutional private lands, including ownership contact information, planting opportunities can be identified on private lands. The master tree planting plan will make tree canopy expansion "shovel-ready" when grants, mitigation funds, fund-raising projects, and partnership agreements are available.

Recommendation 9: Create innovative solutions for planting large crown trees

The city should look at options for creative partnerships and for creating larger growing sites for trees in the street right-of-way. Restricted growing areas for medium to large canopy trees is a limitation to expanding tree canopy in the city. Larger growing areas improve the survival rate of planted and developing trees, and increasing planting space can reduce the amount of tree related infrastructure conflicts. The city should consider these solutions:

- Plant on the right-of-way edge if it is adjacent to open lawn, and/or if there is at least two feet of right-way beyond the edge of a sidewalk.
- Consult with legal staff about planting trees on private property using a temporary construction easement.
- Offer private property owners wholesale or reduced prices for purchasing and/or planting large canopy trees on private land.
- Identify suitable areas and plant more shade trees in parks and city-owned parking lots.
- A landscape bump-out, or curb extension, is a vegetative area that protrudes into the parking lane of a street to provide a larger growing space for trees. Spaces like this are effective in beautifying a streetscape, and provide greater storm water retention, along with the added benefit of slowing car speeds at the bump out location.
- Suspended pavement over noncompacted soil, or the implementation of structural cells, can greatly reduce the conflict between trees roots and infrastructure, as well as provide an ideal urban growing environment for the tree. The development of these types of planting sites can be costly and are typically taken on during larger capital improvement projects, due to their construction intensive nature. Engineering solutions such as these should be made part of the city Design Manual.

Recommendation 10: Select tree species that are salt tolerant

When selecting tree species for new planting projects, another factor to consider for sustainability of the urban forest is tolerance to salt intrusion. With more frequent flooding and longer durations of saturation, trees' exposure to salt concentrations is increasing. This is an issue for all coastal areas in the United States; and while scientists are researching breeding and propagation of more salt-tolerant native forest and landscape species, little progress has been made to date. Until more resilient species are created, the city should plant trees known to have a higher tolerance to salt in areas that are expected to flood frequently, such as:

- Black olive *(Bucida buceras)*
- Bontia *(Bontia daphnoide)*
- Frangipani (*Plumeria* spp.)
- Geiger tree *(Cordia sebestena)*
- Japanese pagoda-tree *(Sophora japonica)*
- Live oak *(Quercus virginiana)*
- Mahogany *(Swietenia mahogany)*
- Ochrosia *(Ochrosia elliptica)*
- Pigeon plum *(Coccoloba laurifolia)*
- Satin leaf *(Chrysophyllum oliviforme)*
- Silver button-bush *(Conocarpus erectus)*
- Tabebuia *(Tabebuia argentea)*

Action Step 3: Set a UTC Goal

Setting a tree canopy goal is an important step in the planning process, as goals provide metrics by which performance can be measured throughout the coming years. The process of setting a goal with the input of multiple stakeholders is also helpful to ensure that goals are realistic.

Currently, St. Augustine has approximately 24% tree canopy cover (35% excluding the open water land cover). The general assessment also determined that a 53% tree canopy cover is possible.

Recommendation 11: Set an urban tree canopy goal that balances the need for shade and other tree benefits with the city's economic development goals and plans and accommodates municipal infrastructure

There are a number of ways canopy goals can be set:

- ***Comparisons to an Industry or Regional Standard.*** American Forests, a recognized leader in conservation and community forestry, has established standards and goals for canopy cover in metropolitan areas. They recommend that cities have an overall canopy of 40%, with 15% in the central business district, 25% in urban neighborhoods, and 50% in suburban neighborhoods. The South Florida Urban Tree Canopy Coalition has similar goals.
- ***Comparison to What is Possible.*** Relative canopy is a measure of how much canopy has been achieved compared to what is possible. This metric is useful to setting realistic goals for very different areas. St. Augustine has a potential canopy cover of 53%. The current UTC is 24%, making relative canopy 45% (24% divided by 53%) Without open water, the relative canopy is 66% (35% divided by 53%). Relative tree canopy is a logical metric to measure until an actual canopy goal is set.

- ***Outcome-Based Goals.*** Choosing a canopy goal based on the desired benefits outcome, e.g., reduction in heat stress, stormwater intercepted, etc., is also a possibility using i-Tree analysis projections.
- ***Neighborhood Goals***. Canopy goals can also be set beyond simply citywide numbers. Neighborhoods in need of more canopy (and associated benefits) can help focus preservation and planting activities to areas in need in coming years. These local goals help distribute canopy benefits equally among all residents, no matter where they live.

It is not uncommon to use a combination of the above methods. A phased goal approach is also common, for example achieving no-net-loss within five years, then 27% canopy by 2025. Some cities establish target dates; others have ongoing goals. Some establish target percentages; others aim for an increase of any kind. This is a topic that should be explored and discussed with leadership from the Street Tree Advisory Committee.

Action Step 4: Improve Ordinances and Policies

For a municipality to legitimately claim to have a comprehensive urban forestry program, a strong tree ordinance should be in place. A tree ordinance establishes standards and sets guidelines for the management of trees by the municipality and the treatment of trees by private entities. It is the legal framework within which local tree management activities are conducted for the general welfare. Tree ordinances can enhance the community-wide urban forest and ensure that it is protected to provide public health and safety as well as many other important benefits.

St. Augustine recognizes trees as community assets. The City's Comprehensive Plan acknowledges the importance of native tree cover in the Conservation and Coastal Management Element, and Chapter 25 Trees and Landscaping and Chapter 11 Environmental Protection of the city code state the city's goals for tree protection and public safety and have requirements to achieve those goals. However, the Comprehensive Plan should have a greater focus on trees and tree canopy, and the ordinance sections should be reviewed and updated to reflect current industry standards. Redevelopment and in-fill projects are the current threat to the urban tree canopy; and in anticipation of this trend, the city should be proactive by strengthening tree planting and requiring innovative tree preservation techniques. Improvements to both planning documents and codes will aid the city to properly manage, protect, and grow the urban tree canopy, and will better reflect the community's future goals.

The following general recommendations are made for St. Augustine to consider for strengthening its existing planning documents and code of ordinances:

Recommendation 12: Incorporate urban tree canopy and public tree management issues into the Comprehensive Plan during regularly scheduled Plan evaluations and updates

At a minimum, the mapping and data from a UTC analysis should be part of the Future Land Use Element. Additionally, as appropriate, goals and action steps related to proactive tree population management on both public and private properties should appear in the Infrastructure, Recreation and Open Space, Historic Preservation, and Capital Improvements Elements.

Recommendation 13: Update Chapter 25 Trees and Landscaping and consider adding new sections to this ordinance

The overall recommendations to improve the city ordinances are:

- Cite arboricultural and horticultural industry standards, such as all Parts of ANSI A300 Tree, Shrub, and other Woody Plant Management – Standard Practices, ANSI Z133.1 American National Standards for Arboricultural Operations – Safety Requirements, and ANSI Z60.1 – American Standard for Nursery Stock or the current edition of the State of Florida's Grades and Standards for Nursery Plants.
- Review and update/clarify or add new definitions as needed.
- Rethink the need to include species tree/plant lists and specific details such as plant sizes, clearance requirements over streets and sidewalks, etc. Materials and methods of tree care, planting, and management often change, and when these changes occur in the industry, St. Augustine's ordinances would then be out-of-date.
- Create a user-friendly companion guide for Chapters 11 and 25 of the code specifically for tree removal and land development. Specific details about items, such as allowed species, invasive species, street and sidewalk clearance standards, and tree protection measures, could be included in a separate manual or best practices guidance document that be updated more easily than the ordinance. This manual could also include helpful information such as guidelines on where trees can be planted on private property (or where not to plant) based on utilities, spacing, and energy use. It could clearly and simply explain the permit process and provide contact information for key city staff.
- Improve and/or strengthen penalties for violations of tree ordinances. It is unclear and cumbersome for the reader to understand the penalties for violations. Additionally, the city should consider adding compensatory payments in the ordinance. The city should have the authority to collect compensatory payments for unauthorized tree removal or damage. Sample language might be:
  - *No person shall remove any public tree without replacing such tree with a tree of equivalent dollar value in the vicinity of the removed tree. The value of a tree shall be determined by the city considering the species, location, size, and condition of the tree. If no suitable location exists in the vicinity of the tree removed or if the replacement tree is of lesser value, the person causing the tree to be removed shall make a compensatory payment to the City of St. Augustine equal to the difference in value between the tree removed and any replacement tree. Compensatory payment shall also be made if a tree is damaged with the amount equal to the cost of mitigation plus reasonable administrative costs for performing the repair. Compensatory permits shall be paid into a fund established for that purpose and restricted to use for urban forestry programs. Compensatory payments may be in addition to other penalties."*
- Enforce Section 25-31 (c) of the current ordinance and make abutting owners pay for tree branch and shrub clearance work over rights-of-ways.

- In the future, it may be advisable to revise the current tree ordinance to include language specifically relating to utility pruning and maintenance activities. The Ordinance could state that, "W*hen maintaining public trees for aerial line clearance, a public utility shall observe good arboricultural practices, as specified by the International Society of Arboriculture and the American National Standards Institute (ANSI) A300 Standards*." Or, it might state that "*An annual permit may be issued for routine utility pruning if pruning methods comply with International Society of Arboriculture and ANSI standards. The city's arborist shall periodically examine utility work to assure compliance.*" These statements, or others like them, placed in the tree ordinance would officially declare the city's acknowledgement of utility companies' important responsibilities, and also the need for following professional standards during such work. Fees could be charged for annual or project-specific permits in amounts needed to cover staff time for reviews and inspections. If utility companies do not comply with permit conditions or national standards and damage public trees, then the city would have recourse to collect damages from or have appropriate mitigation performed by the utility company.

St. Augustine may want to refer to and investigate the manner in which other cities in the region define tree damage and penalize violators.

According to ISA's study of over 160 tree ordinances, multiple types of penalties have been used in tree ordinances, including fines, jail terms, and forfeiture of performance bonds. These penalties are also often accompanied by specific replacement requirements. Many appear to deter offenders, but only if consistent enforcement and authority are set in place early on (ISA 2001).

Recommendation 14: Seek ways to improve inter-departmental communication and create practical policies

City departments are supportive of each other's missions and priorities; however, for tree management tasks and activities that affect public trees, better communication and information sharing should be in place. For instance, for increasing public safety and decreasing municipal liability, a Standard Operating Procedure (SOP) or other administrative directive is needed that requires notifying Public Works/Streets and Grounds if tree roots are cut during emergency repairs and/or for sidewalk and utility construction. A SOP would be useful for Planning and Building/Code Enforcement and Public Works/Streets and Grounds staff to coordinate notifying private property owners to prune private trees and shrubs obstructing the right-of-way, and if they do not comply in a timely manner then sending the invoice for reimbursement or placing a lien on the property.

Action Step 5: Identify New or Supplemental Funding Sources

Unsurprisingly, many cities cite their biggest impediment to implementing and sustaining a proactive tree care and planting plan is funding. There is no national standard for the best or most effective urban forest budget allocation. The allocation between activities may always be in flux depending on the condition of the trees, the planting needs, the incidences of severe weather, the presence and types of insect and disease threats, and the desires of the citizens and community leaders at the time the budget is developed.

While there is currently no specific budget line item for urban forest management and many city departments "touch" public trees, St. Augustine reports that the annual urban forest management expenses are approximately $278,000. Using general expenditure categories, the annual city budget is allocated to these items/tasks:

- $132,000 – Clearance pruning
- $50,000 – Administration; staff
- $50,000 – Storm response
- $38,000 – Maintenance and planting
- $8,000 – Miscellaneous responsibilities/tasks

City Remediation for Damages to Public Trees

Tree Damage Defined in Miami-Dade Ordinance. In Miami, fines are instituted for violations of *any tree abuse* including "damage inflicted upon any part of a tree, including the root system, by machinery, construction equipment, cambium layer penetration, storage of materials, soil compaction, excavation, chemical application or spillage, or change to the natural grade. Hatracking <topping>, girdling or bark removal of more than one-third (1/3) of the tree diameter, and tears or splitting of limbs..." are all considered damage to public trees.

Atlanta Tree Ordinance Violation Rates. Atlanta, Georgia assesses penalties for tree damage and removal with steep fines for violations. The first violation is a minimum of $500; the second violation is $1,000. If the violation cannot be tied to an exact number of trees (for example in a natural area), fines are set at $60,000.00 per acre of land affected (Atlanta 2015).

Additional Remedial Action for Tree Damages in Sunrise, FL. Tree Code Sec 16-173: "In the event a person abuses a tree in violation of this section, the violator, in addition to being subject to the penalties found in section 1-15 of the City Code, shall be responsible to undertake pruning and other remedial actions that the city determines are reasonably necessary to protect public safety and property, and to help the tree survive the tree abuse damage. If the natural habit of growth of the tree is destroyed, the violator shall remove the abused tree and install a replacement tree."

Tree Permits and Costly Consequences in Raleigh, North Carolina. Raleigh requires a $100 tree impact permit for any work done in the right-of-way where trees are located. Activities that require this permit include heavy equipment use or storage of soil, stone, or mulch in the critical root zone. Raleigh reminds its citizens "remember, you can greatly reduce costs by protecting a tree at the beginning of a project rather than paying up to thousands of dollars for removal and replacement at the end of a project when an impacted tree becomes hazardous" (Raleigh 2015).

Cincinnati Utilizes CLTA Assessed Value to Set Violation Fee. In Cincinnati, if a property owner or contractor significantly damages a public tree, they are charged the assessed landscape value (set by Council of Tree & Landscape Appraisers) of the tree. A 20" DBH maple, for instance, has a landscape value of over $2,000. In addition, they are charged the cost of its removal and new replacement planting. These penalties make tree protection and preservation a priority for both the public and contractors. All revenue is deposited into a dedicated urban forestry fund (Gulick 2015).

The five-year priority and proactive public tree maintenance plan (presented in Recommendation 6) recommends an annual budget of at least $38,000 to provide cyclical pruning, priority removal, young tree maintenance, and replacement tree planting. It appears St. Augustine has sufficient funding to begin this important transition from a reactive public tree management program to a proactive one.

However, other important urban forest management tasks and recommendation in the plan also require sufficient funding. The program's remaining budget needs to support equipment purchases, rentals, or other capital expenditures, additional full- or part-time staffing, plant health care, storm response, risk management, invasive pest management, staff training and development, volunteer programming and coordination, additional urban forest management analyses, and expanded public outreach. While not in the scope of this planning project, the current budget allocations may be insufficient for these other important activities and a citywide departmental financial analysis should be conducted to determine the actual urban forest management expenditures incurred by the city.

Recommendation 15: Consider supplemental funding options

Through information obtained from stakeholder engagement, staff interviews, and innovative funding techniques used by cities across the country, options for funding new urban forestry initiatives and expanding the existing program are offered for the city's consideration:

How to Increase Tree Benefits and Reduce Costs

Communities and homeowners can increase the benefits of the urban forest and decrease the costs by following guidelines for proper management and care.

- Determine and prioritize long-term objectives and a desired future for your urban forest.
- The less maintenance a tree requires, the lower its financial costs (use low-maintenance, drought-resistant, salt-tolerant trees).
- Trees in harsh urban sites will incur greater financial and environmental costs than established trees in parks and natural areas.
- Longer-lived, large canopy trees will reduce costs and delay removal expenses.
- Established forests and trees need less maintenance, so preserving them should take precedence over planting new trees.
- Understand the community's attitudes and perceptions toward the urban forest.
- Seek public input during the development of management goals and objectives.
- Plant the right tree in the right place.

(Excerpted from "The Costs of Managing an Urban Forest," University of Florida, IFAS Extension)

1. **Reclaim city funds spent pruning public trees for road and sidewalk clearance**. The city reports that nearly 50% of the annual urban forest management budget is spent providing clearance over streets and sidewalks. The vast majority of this work is performed by city crews on privately owned trees. Section 25-31 (c) of the city's ordinance clearly states that *"The planning and building director, in conjunction with a recommendation from an arborist, ...may order trees on private land that cause obstructions, present insect or disease problems, or otherwise present a danger to public health or safety on public right-of-way or public property to be pruned, removed or treated, and assess costs against the property owner."* The lawful and reasonable recovery of these funds should be the first priority of the city, as well as educational efforts to make property owners aware of their responsibility so that the city does not have to perform the pruning in the first place.

2. **Authorize a tree assessment fee.** The justification and use of a tree assessment fee would be much like the city's fire assessment fee. All properties benefit from the city's tree canopy and public trees, and an assessment would ensure that every property contributed equitably to sustaining the urban forest. The assessment can be levied as a fee per foot of right-of-way frontage or as a percentage of the property value. In a recent University of Florida study, property owners said they would pay up to $7 more per month for tree planting and maintenance in their neighborhoods. The findings of the study indicate that citizens are interested in urban forest infrastructure and are willing to pay for the benefits of having more trees near their homes. In fact, from the informal survey of St. Augustine residents, 81% responded that they would support increased funding for urban forestry activities.

3. **Allocate a portion of a future stormwater fee increase to the urban forestry program.** Trees play a significant role mitigating the city's stormwater issues. As the benefit calculations proved, the public trees alone provide the city an estimated $41,296 in stormwater runoff services with the average benefit per tree equaling $60.76 per year. Acknowledging the large contributions trees make to municipal stormwater programs, cities across the country, St. Augustine could use stormwater fees to support tree planting and urban canopy maintenance. Milwaukee funds the majority of its premiere urban forestry program through its stormwater fees.

4. **Use existing city funds and resources for special urban forest management projects.** The city has existing funds and programs that could be accessed for tree planting, tree maintenance, public education, and further urban forest analyses. For instance:

    - *Tourist Development Council Funding:* Use for plant health care for St. Augustine's iconic mature live oaks and other trees; supporting a Historic Tree program; developing a "tree trail" for visitors; replacement tree planting in parks, public areas, parking lots, and near beach accesses.

    - *Tree Mitigation Fund:* This fund exists for replacement tree planting; however, the fund's administration should be reviewed and guidelines developed that allow more flexible use of these funds for urban forest management beyond planting; the city should also review the fees assessed and consider increasing them.

- *Fund Raising Programs:* Seek support for defined projects directly from the citizens of St. Augustine. Fund raising through "A Buck for Ancient/Veteran Trees", recreational events like walk/runs, concerts, etc., and utility round-up donation programs are usually well received by citizens.
- *Lincolnville Community Redevelopment Area:* The Lincolnville Redevelopment Plan aims to improve infrastructure, neighborhood amenities, and aesthetics in Lincolnville. A healthy, vibrant urban tree canopy in this neighborhood could help accomplish many of the plan's goals (i.e., reducing blight, controlling stormwater, enhancing historic preservation). Lincolnville CRA funding should be made available for dead tree removal, tree pruning, and tree planting in this neighborhood.

5. **Seek grants from non-traditional sources.** The State's Division of Forestry has offered urban forest grants for decades. However, there other granting agencies and private foundations that may provide funding for St. Augustine to support historic tree preservation, native habitat conservation, community involvement, tree planting, and other projects. Consider applying for grants focused on the benefits trees provide, not just forestry-related grants (i.e., grants with an air quality focus, urban heat island, stormwater management, public health, and watershed-based funding). Grants and philanthropic funding should be carefully coordinated with city funding and should follow policies and procedures already in place. It is critical that private funding supplement the city's public funding rather than replace it. The city can use the St. Augustine Neighborhood Council's status and influence as a 501(c)3 organization to apply for, secure, and hold grants and donations.
6. **Ensure the city receives all qualified FEMA reimbursements.** FEMA is the major federal agency that will be a partner of the city in the event of a severe storm emergency. FEMA will reimburse the city for the costs of debris removal, hazard reduction pruning, and removal of certain trees in the rights-of-way if a federal disaster is declared. Final reimbursement of storm-related damages from FEMA is dependent on accurate record keeping and documentation of storm-related cleanup work. This is another reason the city should be diligent at updating the tree inventory database.
7. **Explore interlocal agreements for urban forest management.** Tree benefits are not provided or confined by jurisdictional boundaries; tree benefits extend beyond city limits to the region. Therefore, it could be financially beneficial for St. Augustine to enter into an interlocal agreement with adjacent communities for more efficient, cost-effective tree maintenance and planting projects. The Florida Interlocal Cooperation Act of 1969 empowers "public agencies to enter into contracts for the performance of functions" which will "permit local governmental units to make the most efficient use of their powers by enabling them to cooperate with other localities on a basis of mutual advantage" and authorizes the contracting units of local governments to enter into an agreement to provide services and facilities in a manner "that will accord best with geographic, economic, population, and other factors influencing the needs and development of local communities." Pooling urban forest resources and funding with other jurisdictions could result in more competitive annual tree maintenance and planting contract prices, better pricing for coordinated wholesale tree purchases for property owners, and being more efficient and timely in treating insect pests and disease issues and removing invasive trees and plants, and sharing specialty equipment and assisting each other during and after severe weather events.

   With sufficient financial resources to secure professional services, equipment, and management, the city can accomplish its goals, better respond to changes and challenges in the urban forest, and best serve the citizens of St. Augustine.

Action Step 6: Perform Public Engagement and Build Partnerships

Performing public outreach and building partnerships is essential to maintaining a quality urban forest and long-term increases in tree canopy. City actions alone have limitations to improving and increasing the urban tree canopy because public land accounts for only a small percentage of land ownership in most cities. Fortunately, St. Augustine residents and other stakeholders have expressed the desire to get more involved. Positive public sentiment and a collective sense of priority for tree canopy can also result in more support/funding for public tree care budgets; and outreach efforts often reveal new partners and funding sources that otherwise can go untapped.

An education and outreach campaign will:

1. Foster an understanding of the connection between trees and the services they provide to the community, which contributes greatly to a high quality of life.
2. Prompt residents and businesses to take action in tree preservation and planting (or other needed actions) on private and public lands.
3. Cultivate support for public tree funding and management.
4. Convey the city's prioritization of trees as essential city infrastructure (leadership by example).

Recommendation 16: Develop messaging that resonates

Today's society is characterized by sound-bites and short attention spans. Combine this with the fact that the human brain does not retain a lot of information all at once, and the need for limited and concise messages about the urban forest becomes evident. Craft messages in terms of what people want for themselves and their neighborhoods, and what the public needs to know about the city's urban forestry program or trees in general. This means making the connection between trees and solutions to urban problems. Messages can also address some of the more emotionally-based tree perception issues. The most common of which is fear (i.e., trees, houses, and hurricanes together), but also the perception that trees are mostly work (messy, dirty, leaf clean-up).

Examples of Translating Public Desires to Effective Tree Messaging Topics	
Community Survey reveals that the public wants…	Potential related tree messages or topics could then be centered on…
…safe and inviting streets for residents and tourists.	Trees can help slow traffic, create safe, interesting, and vibrant neighborhoods, and are a key piece to a walkable and bike-friendly city by slowing traffic and providing safe buffers for pedestrians
…stable business districts	Tree-lined business districts encourage shoppers to pay more and stay longer
…to engage youth and young families to become a more vibrant community.	Imagine signs that say "Join your neighbors in the next tree planting project. Come get your hands dirty. All ages welcome!"
… inclusion of all cultures, bridge perceived differences.	Neighborhood-wide tree planting projects or tree events that include all people.
…an attractive city people want to live and work in, for an improved perception of city by visitors.	Cities with tree canopy have property values 7–15% higher than cities without tree canopy.

Recommendation 17: Develop an outreach plan

Outreach and implementation is where the messages are put to work. It involves defining audiences, partnerships, and reaching out to the public, with the goal of getting the audience to support and participate in the care of the city's urban forest. There are distinct groups and individuals that actively impact the urban forest, such as homeowners, businesses, non-profits, schools, green industry professionals, and other civic groups. All can provide valuable assistance and support for urban forestry initiatives. However, each group or segment views the urban forest differently and each have different priorities or goals. Typically, a blanket, one-message-fits-all approach is not effective. Therefore, each segment should be approached with the message that will most resonate with them. Each constituent group should be approached in a targeted way and informed of the vision, mission, and strategies of the urban forestry program and how it can get involved.

Recommendation 18: Create strong partnerships

Sustainable outreach requires partnerships for long-term results. Each audience has the potential to produce partnerships and new community leaders can emerge throughout this process. Strong partnerships can occur where entity missions match up. Effective partners can be found in groups that prioritize the services trees provide (not trees themselves). For example, neighborhood associations, public health organizations, community revitalization, and watershed groups may produce effective partnerships. Large landholders (often businesses) can have a significant impact on increasing tree canopy simply due to large amounts of land available for trees. Large businesses also tend to have an interest in making their community a nicer place to live and work to retain good employees. St. Augustine may want to first begin cultivating partnerships with the many school and educational organizations in the city and county, such as Flagler College, University of Florida, St. Johns County Extension office, and local schools.

Recommendation 19: Maximize the city's communication resources and talents

The city uses a wide variety of public outreach tools that can convey urban forest messaging, such as the city's website, nearly all major social media platforms, a weekly e-publication, utility bill inserts, and the G-TV government television channel. The city's Public Information Officer expertise can aid developing, delivering, and analyzing a variety of messaging whether they are seasonal tips or timely safety notices. A volunteer can assist the program by writing copy, taking photographs, and managing a media calendar.

Recommendation 20: Create a "Tree Stewards" Program

Consider implementing an urban forestry support program comprised of volunteers, often called "tree stewards," to assist with tree planting, invasive removal, public education, and new tree care such as watering, mulching, and pruning. This type of program provides yet another engagement opportunity and encourages partnership opportunities with youth groups (scout troops, church affiliated groups, high school community service programs), youth job corps programs, and/or garden clubs to accomplish many public tree care tasks. Tree stewards could even be used to help plant trees on private property when the owners are unable to do it themselves. Such a program does involve initial and continuing training, frequent mentoring, and overall coordination of the process and volunteers. While staff time is needed to sustain such a program, it may be a worthwhile investment into the community.

Action Step 7: Increase Staff Dedicated to the Urban Forest Management Program and Provide Training

Proactive and professional municipal urban forest management requires that experienced and well-trained managers and arborists are readily available to perform a wide variety of tasks that are critical to the success of implementing St. Augustine's urban forest management plan and creating a sustainable urban forest.

Recommendation 21: Add a field arborist position

Current city staff managing public trees are admirably executing their duties and enforcing city codes and policies, but are also performing other public works duties and do not have the time to take on the additional work and efforts required to implement many recommendations of this plan. An additional field arborist is recommended; this position could conduct annual plant health care, risk, and post-storm event inspections on mature trees, conduct the annual cyclical maintenance inspections and inventory updates, and report findings to the city arborist; perform ongoing minor tree work such as new and small tree care, tree planting, and plan and conduct public education events. This role, if dedicated and full-time, could also assume and assist with perform land development site inspections, and coordinating and managing Tree Steward volunteers.

Recommendation 22: Provide training to staff and encourage professional certifications

The work involved in urban forest management has to be performed by trained, knowledgeable persons. The City of St. Augustine should have a comprehensive, ongoing, and consistent training program for staff performing program management tasks and/or tree maintenance or planting operations. A quality training program is integral to keeping workers on the grounds safe, efficient in their work, and motivated about learning new skills. Training does more than just educate. Training supports professional development and job advancement, provides clear direction and expected performance outcomes, and positively influences the engagement levels, productivity, and attitudes and behaviors of staff. Recommendations for urban forestry training are:

- Staff should receive regular and updated training sessions for first-aid and CPR, chainsaw use, tree risk assessment, and minimum approach distances for energized electric lines to ensure that people are working safely and effectively.
- Create a training program for the city's grounds staff that focuses on new and young tree care, proper pruning, fertilization, and mowing techniques to prevent injury to trees.
- Request local tree service companies, landscapers, University of Florida Extension, and other local and regional professional organizations to provide free training for staff on appropriate topics.
- Provide current or future city staff the opportunity to become International Society of Arboriculture Certified Tree Workers, Certified Arborists, Municipal Specialists, and/or obtain the Tree Risk Assessment Qualification.
- Seek out low or no-cost training to use the U.S. Forest Service's i-Tree tools, and training on using the city's tree inventory database management software and field applications.

Action Step 8: Regularly Update the Plan, UTC, and Inventory and Monitor the Plan's Success

The best approach to sustaining an urban forest and a proactive tree management program is to have up-to-date, accurate data available from a public tree inventory, urban tree canopy assessment, benefit calculations, and a municipal tree management plan.

Recommendation 23: Update urban forest data and planning documents

- Update the tree inventory database on a weekly, monthly, or semi-annual basis using CityWorks or a tree data management software program to record when maintenance or planting work is performed, track work history, and evaluate productivity to plan work and project budgets.
- Every year, re-inventory 20% of the street and park tree population by conducting a Level 2 assessment, and conduct a Level 1 assessment on the remaining 80% of the street and park tree populations. If this cannot occur, re-inventory the entire public tree populations every ten years.
- Provide urban forest management staff training, access to customized mobile field applications, and all necessary equipment to be more productive.
- Update the tree canopy assessment. Using the i-Tree Canopy project files, perform a canopy analysis every 5 years or when new satellite imagery is available.
- Review and update the municipal tree management plan at least every five years. Updating may also occur in any given year that major shifts in funding, personnel, and the conditions of the urban forest occur.

Recommendation 24: Monitor the Plan's implementation and success

Monitoring refers to the periodic and systematic measurement of processes and metrics to gauge success. The city should institute three forms of monitoring in association with the management plan: implementation, effectiveness, and validation.

The implementation monitoring will determine if the plan is being implemented as designed within resource and funding constraints. It asks, "Did we do what we set out to do?"

Effectiveness monitoring determines if the action achieved stated goals and objectives. It asks, "Did it work?"

Validation monitoring determines if assumptions, data, and models being used to make decisions are valid and appropriate.

In every fifth year, a staff and stakeholder meeting(s) should include an in-depth evaluation to measure the effectiveness of the city's tree management program and monitor the plan's implementation. Benchmarks to measure this success can be developed based on plan goals. See Table 11 below as an example of how to translate goals into benchmarks.

Table 11. Examples of Translating Goals into Benchmarks to Measure Future Progress

If the City's goal is:	Potential benchmark could be:
All public trees are in good condition and well maintained.	70% of all trees are in Good or Excellent condition and are maintained to maximize current and future benefits.
Historic and/or mature trees are preserved.	60% of historic or trees over 28" DBH are in Fair to Good condition.
The city's urban forest population is diverse.	No species represents no more than 10–15% of the citywide tree population.
Invasive trees are controlled on public property.	No more than 5% of inventoried trees are considered invasive species.
The public urban forest is safe.	All high risk removals and prunings are complete, and all publicly managed trees are free of recognized hazards.
The city's urban forest and tree canopy is appreciated and valued by the public.	Quantify public engagement numbers – number of volunteer project participants, educational programs/outreach efforts, and partnerships in place.

IMPLEMENTATION OF RECOMMENDATIONS

The primary goal of the city is to implement the 2018 Urban Forest Management Plan to create a safe, sustainable, and attractive urban forest, and incrementally expand tree planting and public outreach. To that end, the recommendations made in this plan for improving administrative, financial, and operational efficiencies and effectiveness and making better, more meaningful connections with the public have been summarized in Table 12. These recommendations have also been prioritized, and estimated costs have been provided where applicable and known.

Table 12. Prioritized Compilation of Recommendations with Estimated Costs to Improve Urban Forestry Management and Service Delivery

Action Step	Recommendation	Timeframe	Fiscal Impact	Priority
Perform Priority and Proactive Maintenance: General	1. Remove designated trees and inspect poor condition trees	Short term (1–5 years)	$48,000 (estimated total for 5 years)	High
	2. Update the inventory database regularly	Short term (1–5 years)	$0 (staff time)	High
Perform Priority and Proactive Maintenance: Pruning	3. Perform tree pruning on trees identified as Extreme, High, and Moderate Risk	Short term (1–5 years)	$10,000 (estimated total for 5 years)	High
	4. Implement a 3-year young tree maintenance cycle	Short term (1–5 years)	$15,000 (estimated total for 5 years)	High
	5. Establish a 5-year routine pruning cycle	Short term (1–5 years)	$97,000 (estimated total for 5 years)	High
Perform Priority and Proactive Maintenance: 5-Year Cycle and Budget	6. Allocate at least $38,000 annually for proactive tree care and planting	Short term (1–5 years)	$38,000/year	High
Practice Purposeful Planting	7. Avoid planting additional live oaks and palms, favoring other high-benefit species	Mid-term (5–10 years)	NA	Medium
	8. Create a citywide master tree planting plan	Long term (10+ years)	$0 (staff time) $12,000 (consultant)	Medium
	9. Consider innovative solutions to restricted growing areas for large trees	Mid-term (5–10 years)	$0 (staff time)	High
	10. Select salt-tolerant species when possible	Mid-term (5–10 years)	NA	High

Action Step	Recommendation	Timeframe	Fiscal Impact	Priority
Set a UTC Goal	11. Set a UTC goal with stakeholder input	Mid-term (5–10 years)	$0 (staff time)	Medium
Improve Ordinances and Policies	12. Incorporate urban forest data and goals into the Comprehensive Plan	Short term (1–5 years)	$0 (staff time)	Medium
	13. Update Chapter 25 - Trees and Landscaping	Mid-term (5–10 years)	$0 (staff time) $12,000 (consultant)	Medium
	14. Improve inter-departmental policies and communication	Mid-term (5–10 years)	$0 (staff time)	Low
Identify New or Supplemental Funding	15. Consider funding options	Mid-term (5–10 years)	$0 (staff time)	Medium
Perform Public Engagement and Build Partnerships	16. Develop compelling messages	Mid-term (5–10 years)	$0 (staff time) $5,000 -10,000 (consultant)	Medium
	17. Develop an outreach plan	Mid-term (5–10 years)	$0 (staff time) $5,000–$10,000 (consultant)	Medium
	18. Create strong community partnerships	Long term (10+ years)	$0 (staff time)	Medium
	19. Maximize the city's communication resources and talents	Mid-term (5–10 years)	$0 (staff time)	Low
	20. Create a Tree Stewards program	Long term (10+ years)	$0 (staff time)	Low
Increase and Train Urban Forestry Staff	21. Add a field arborist position	Mid-term (5–10 years)	$45,000 annually	Medium
	22. Provide training for staff	Short term (1–5 years)	$1,000–$2,000 annually (dues, training, and certification fees)	Medium

Action Step	Recommendation	Timeframe	Fiscal Impact	Priority
Regularly Update and Monitor the Plan, UTC, and Inventory	23. Update urban forest data and planning documents	Mid-term (5–10 years)	$0 (staff time) $15,000 (UTC mapping/analysis by consultant)	High
	24. Monitor the Plan's success	Mid-term (5–10 years)	$0 (staff time)	High

CONCLUSION

The recommendations made in this Plan are intended to be considered and implemented over a period of five to ten years. The results of this Plan's implementation, in relation to achieving the goals, objectives, and final measurable results of a proactive forest management program and maintaining or expanding the urban tree canopy cover, may take more time.

Trees are long-lived organisms, and by planting trees today the city is actually planting them to provide their benefits for future generations of citizens. However, by having systematic tree planting and maintenance programs in place, and by having adequate funding, staffing, regulations, and public education resources today, the current and future public tree population and overall urban forest will be expanded and sustainable.

St. Augustine's urban forest is a municipal asset and amenity that appreciates over time because it is alive and growing. The trees provide tangible and intangible benefits to the city and its citizens. Because of their significance to the environmental, social, and economic well-being of the city, trees and the urban forest should be professionally managed and protected to preserve them now for all citizens and to expand them for future citizens.

GLOSSARY

aesthetic report: The i-Tree Streets Aesthetic/Other Report presents the tangible and intangible benefits of trees reflected by increases in property values in dollars ($).

air quality report: The i-Tree Streets Air Quality Report quantifies the air pollutants (ozone [O_3], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], coarse particulate matter less than 10 micrometers in diameter [PM_{10}]) deposited on tree surfaces and reduced emissions from power plants (NO_2, PM_{10}, Volatile Oxygen Compounds [VOCs], SO_2) due to reduced electricity use measured in pounds (lbs.). Also reported are the potential negative effects of trees on air quality due to Biogenic Volatile Organic Compounds (BVOC) emissions.

American National Standards Institute (ANSI): ANSI is a private, nonprofit organization that facilitates the standardization work of its members in the United States. ANSI's goals are to promote and facilitate voluntary consensus standards and conformity assessment systems, and to maintain their integrity.

ANSI A300: Tree care performance parameters established by ANSI that can be used to develop specifications for tree maintenance.

arboriculture: The art, science, technology, and business of commercial, public, and utility tree care.

canopy: Branches and foliage that make up a tree's crown.

canopy cover: As seen from above, it is the area of land surface that is covered by tree canopy.

carbon dioxide report: The i-Tree Streets Carbon Dioxide Report presents annual reductions in atmospheric CO_2 due to sequestration by trees and reduced emissions from power plants due to reduced energy use in pounds. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.

condition: The general condition of each tree rated during the inventory according to the following categories adapted from the International Society of Arboriculture's rating system: Excellent (100%), Very Good (90%), Good (80%), Fair (60%), Poor, (40%), Critical (20%), Dead (0%).

cycle: Planned length of time between vegetation maintenance activities.

defect: See structural defect.

diameter: See tree size.

diameter at breast height (DBH): See tree size.

extreme risk tree: Applies in situations where tree failure is imminent, there is a high likelihood of impacting the target, and the consequences of the failure are "severe." In some cases, this may mean immediate restriction of access to the target zone area in order to prevent injury.

failure: In terms of tree management, failure is the breakage of stem or branches, or loss of mechanical support of the tree's root system.

further inspection: Notes that a specific tree may require an annual inspection for several years to make certain of its maintenance needs. A healthy tree obviously impacted by recent construction serves as a prime example. This tree will need annual evaluations to assess the impact of construction on its root system. Another example would be a tree with a defect requiring additional equipment for investigation.

genus: A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature, the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.

geographic information system (GIS): A technology that is used to view and analyze data from a geographic perspective. The technology is a piece of an organization's overall information system framework. GIS links location to information (such as people to addresses, buildings to parcels, or streets within a network) and layers that information to provide a better understanding of how it all interrelates.

grow space size: Identifies the minimum width of the tree grow space for root development.

high risk tree: The High Risk category applies when consequences are "significant" and likelihood is "very likely" or "likely," or consequences are "severe" and likelihood is "likely." In a population of trees, the priority of High Risk trees is second only to Extreme Risk trees.

inventory: See tree inventory.

i-Tree Streets: i-Tree Streets is a street tree management and analysis tool that uses tree inventory data to quantify the dollar value of annual environmental and aesthetic benefits: energy conservation, air quality improvement, CO_2 reduction, stormwater control, and property value increase.

i-Tree Tools: State-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. The i-Tree Tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of community trees and the environmental services that trees provide.

management costs: Used in i-Tree Streets, they are the expenditures associated with street tree management presented in total dollars, dollars per tree, and dollars per capita.

moderate risk tree: The Moderate Risk category applies when consequences are "minor" and likelihood is "very likely" or "likely"; or likelihood is "somewhat likely" and consequences are "significant" or "severe." In populations of trees, Moderate Risk trees represent a lower priority than High or Extreme Risk.

monoculture: A population dominated by one single species or very few species.

net annual benefits: Specific data field for i-Tree Streets. Village-wide benefits and costs are calculated according to category and summed. Net benefits are calculated as benefits minus costs.

ordinance: See tree ordinance.

overhead utilities: The presence of overhead utility lines above a tree or planting site.

right-of-way (ROW): See street right-of-way.

risk: Combination of the probability of an event occurring and its consequence.

species: Fundamental category of taxonomic classification, ranking below a genus or subgenus, and consisting of related organisms capable of interbreeding.

street right-of-way (ROW): A strip of land generally owned by a public entity over which facilities, such as highways, railroads, or power lines, are built.

street tree: A street tree is defined as a tree within the right-of-way.

structural defect: A feature, condition, or deformity of a tree or tree part that indicates weak structure and contributes to the likelihood of failure.

sulfur dioxide (SO_2): A strong-smelling, colorless gas that is formed by the combustion of fossil fuels. Sulfur oxides contribute to the problem of acid rain.

summary report: A report generated by i-Tree Streets that presents the annual total of energy, stormwater, air quality, carbon dioxide, and aesthetic/other benefits. Values are reflected in dollars per tree or total dollars.

tree: A tree is defined as a perennial woody plant that may grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow as multi-stemmed forms.

tree benefit: An economic, environmental, or social improvement that benefits the community and results mainly from the presence of a tree. The benefit received has real or intrinsic value associated with it.

tree height: If collected during the inventory, the height of the tree is estimated by the arborist and recorded in 10-foot increments.

tree inventory: Comprehensive database containing information or records about individual trees typically collected by an arborist.

tree ordinance: Tree ordinances are policy tools used by communities striving to attain a healthy, vigorous, and well-managed urban forest. Tree ordinances simply provide the authorization and standards for management activities.

tree size: A tree's diameter measured to the nearest inch in 1-inch size classes at 4.5 feet above ground, also known as diameter at breast height (DBH) or diameter.

urban forest: All of the trees within a municipality or a community. This can include the trees along streets or rights-of-way, in parks and green spaces, in forests, and on private property.

urban tree canopy (UTC) assessment: A study performed of land cover classes to gain an understanding of the tree canopy coverage, particularly as it relates to the amount of tree canopy that currently exists and the amount of tree canopy that could exist. Typically performed using aerial photographs, GIS data, or Lidar.

young tree train: Data field based on ANSI A300 standards, this maintenance activity is characterized by pruning of young trees to correct or eliminate weak, interfering, or objectionable branches to improve structure. These trees can be up to 20 feet tall and can be worked with a pole pruner by a person standing on the ground.

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APPENDIX A
TREE INVENTORY AND URBAN TREE CANOPY METHODS

Street/Park Tree Inventory Data Field Definitions

The data fields definitions that will be collected for each tree during the inventory are defined as follows:

Address Input Fields

- **Site identification number**
- **Mapping coordinate.** X and Y coordinate locations.
- **Location.** The tree's physical location in relation to public ROW and/or public space will be recorded.
- **Address**. DRG will identify the location of each street tree and planting site so that they can easily be identified for future maintenance work. Street trees and planting sites will be located using an address number, street name, side of address, and on street.
- **Species.** Trees will be identified by genus and species, with the exception of genera such as *Crataegus* or *Malus*, where field identification of species is often not practical.
- **Diameter.** Diameter is measured in inches at 4-1/2 feet above the ground, or diameter-breast-height (DBH). DBH will be recorded in 2-inch increments. Trees that fork below 4.5 feet in height will be measured at the narrowest point below the fork.
- **Land Use.** The land usage will be recorded where each tree is located. Trees will be identified if they have multiple stems or are a single stem (Residential, Commercial, Industrial, Park, Vacant).
- **Condition.** In general, the health and structure of each tree will be recorded in one of the following categories based on visible root, trunk, scaffold branch, twig, and foliage conditions at the time of the inventory and adapted from the rating system established by the International Society of Arboriculture:
  - Good—80% condition rating
  - Fair—60% condition rating
  - Poor—40% condition rating
  - Dead—0% condition rating
- **Sidewalk Damage.** Sidewalk Damage and Other Conflicts between Tree Roots and Infrastructure (Y/N).

Conflict. The most relevant conflict issue will be recorded for each tree.

- Overhead Wires
- Signs
- Buildings
- Lights
- None

Primary Maintenance Need. The following primary maintenance needs will be determined based on ANSI A300 standard specifications:

- *Removal*—Trees designated for removal have defects that cannot be cost-effectively or practically treated. The majority of the trees in this category have a large percentage of dead crown. All trees with safety risks that could be seen as potential threats to persons or property and seen as potential liabilities to the client would be in this category. This category includes large dead and dying trees that are high-liability risks as well as those that pose minimal liability to persons or property (such as trees in poor locations or undesirable species).
- *Tree Clean*—These trees require selective removal of dead, diseased, dying, and/or broken wood to minimize potential risk. Priority of work should be dependent upon the Risk associated with the individual trees.
- *Young Tree Train*—These are young trees that must be pruned to correct or eliminate weak, interfering, or objectionable branches in order to minimize future maintenance requirements. Generally, these trees may be up to 20 feet in height and can be worked with a pole pruner by a person standing on the ground.

Immediacy/Priority of Primary Management Need.

- Immediate
- <1 Year
- 1-3 Years
- Routine
- N/A

Risk Assessment. A Level 2 qualitative risk assessment will be performed based on the ANSI A300 (Part 9) and the companion publication *Best Management Practices: Tree Risk Assessment*, published by the International Society of Arboriculture (2011). Trees can have multiple failure modes with various risk ratings. One risk rating per tree will be assigned during the inventory. The failure mode having the greatest risk will serve as the overall tree risk rating. The specified time period for the risk assessment is one year.

Likelihood of Failure—Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.

- *Improbable*—The tree or branch is not likely to fail during normal weather conditions and may not fail in many severe weather conditions within the specified time period.
- *Possible*—Failure could occur, but it is unlikely during normal weather conditions within the specified time period.
- *Probable*— Failure may be expected under normal weather conditions within the specified time period.

- *Imminent*— has started or is most likely to occur in the near future, even if there is no significant wind or increased load. The tree may require immediate action.

- **Likelihood of Impacting a Target**—The rate of occupancy of targets within the target zone and any factors that could affect the failed tree as it falls toward the target.
  - *Very low*—The chance of the failed tree or branch impacting the target is remote.
    - Rarely used sites
    - Examples include rarely used trails or trailheads
    - Instances where target areas provide protection
  - *Low*—It is not likely that the failed tree or branch will impact the target.
    - Occasional use area fully exposed to tree
    - Frequently used area partially exposed to tree
    - Constant use area that is well protected
  - *Medium*—The failed tree or branch may or may not impact the target.
    - Frequently used areas that is partially exposed to tree on one side
    - Constantly occupied area partially protected from tree
  - *High*—The failed tree or branch will most likely impact the target.
    - Fixed target is fully exposed to tree or tree part
- **Categorizing Likelihood of Tree Failure Impacting a Target**—The likelihood for failure and the likelihood of impacting a target are combined in the matrix below to determine the likelihood of tree failure impacting a target.

Likelihood of Failure	Likelihood of Impacting Target			
	Very Low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very Likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

- **Consequence of Failure**—The consequences of tree failure are based on the categorization of target and potential harm that may occur. Consequences can vary depending upon size of defect, distance of fall for tree or limb, and any other factors that may protect a target from harm. Target values are subjective and should be assessed from the client's perspective.
  - *Negligible*—Consequences involve low value damage and do not involve personal injury.
    - Small branch striking a fence
    - Medium-sized branch striking a shrub bed
    - Large tree part striking structure and causing monetary damage
    - Disruption of power to landscape lights

- *Minor*—Consequences involve low to moderate property damage, small disruptions to traffic or communication utility, or very minor injury.
  - small branch striking a house roof from a high height
  - medium-sized branch striking a deck from a moderate height
  - a large tree part striking a structure, causing moderate monetary damage
  - short-term disruption of power at service drop to house
  - temporary disruption of traffic on neighborhood street
- *Significant*—Consequences involve property damage of moderate to high value, considerable disruption, or personal injury.
  - a medium-sized part striking a vehicle from a moderate or high height
  - a large tree part striking a structure resulting in high monetary damage
  - disruption of distribution primary or secondary voltage power lines, including individual services and street-lighting circuits
  - disruption of traffic on a secondary street
- *Severe*—Consequences involve serious potential injury or death, damage to high-value property, or disruption of important activities.
  - injury to a person that may result in hospitalization
  - a medium-sized part striking an occupied vehicle
  - a large tree part striking an occupied house
  - serious disruption of high-voltage distribution and transmission power line disruption of arterial traffic or motorways

- **Risk Rating**—The overall risk rating of the tree will be determined based on combining the likelihood of tree failure impacting a target and the consequence of failure in the matrix below.

Likelihood of Failure	Likelihood of Impacting Target			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

Trees have the potential to fail in more than way and can affect multiple targets.

Tree risk assessors will identify the tree failure mode having the greatest risk, and report that as the tree risk rating. Generally, trees with the highest qualitative risk ratings should receive corrective treatment first. The following risk ratings will be assigned:

- **None**—Used for planting and stump sites only.
- **Low**—The Low Risk category applies when consequences are "negligible" and likelihood is "unlikely"; or consequences are "minor" and likelihood is "somewhat likely." Some trees with this level of risk may benefit from mitigation or maintenance measures, but immediate action is not usually required.
- **Moderate**—The Moderate Risk category applies when consequences are "minor" and likelihood is "very likely" or "likely"; or likelihood is "somewhat likely" and consequences are "significant" or "severe." In populations of trees, Moderate Risk trees represent a lower priority than High or Extreme Risk trees.
- **High**—The High Risk category applies when consequences are "significant" and likelihood is "very likely" or "likely", or consequences are "severe" and likelihood is "likely." In population of trees, the priority of High Risk trees is second only to Extreme Risk trees.
- **Extreme**—The Extreme Risk category applies in situations where tree failure is imminent and there is a high likelihood of impacting the target, and the consequences of the failure are "severe." In some cases, this may mean immediate restriction of access to the target zone area to avoid injury to people.

Notes. Additional information regarding disease, insect, mechanical damage, etc. can be included in this field. Additional maintenance recommendations and observations will be noted here.

The data fields definitions that will be collected for each Vacant Site and Stump during the inventory are defined as follows:

Site Identification Number.

Mapping coordinate. X and Y coordinate locations.

Location. The tree's physical location in relation to public ROW and/or public space will be recorded.

Address. DRG will identify the location of each street tree and planting site so that they can easily be identified for future maintenance work. Street trees and planting sites will be located using an address number, street name, side of address, and on street.

Land Use. The land usage will be recorded where each tree is located Trees will be identified if they have multiple stems or are a single stem (Residential, Commercial, Industrial, Park, Vacant).

Size. Available growing space size will be determined.

- Small <100 square feet
- Medium 100–250 square feet
- Large >250 square feet

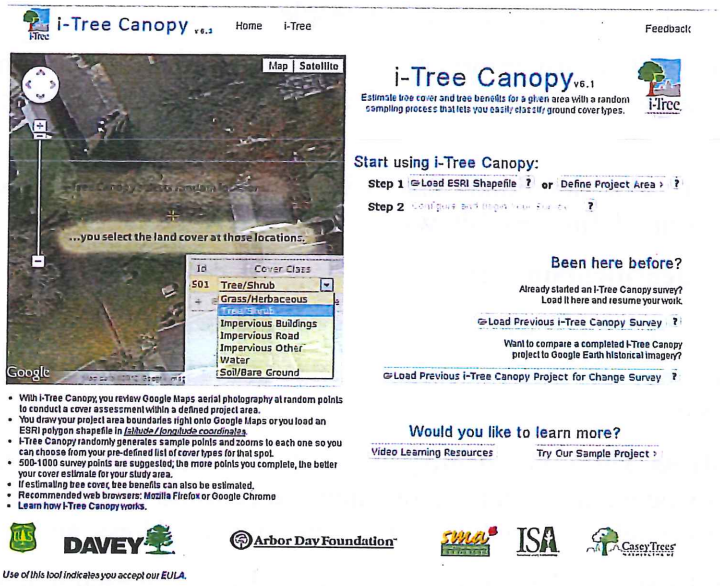
- **Stump Present (Y/N)**
- **Potential Infrastructure Conflicts (Y/N)**

The data fields definitions that will be collected for each palm during the inventory are defined as follows:

- **Site Identification Number**
- **Mapping coordinate.** X and Y coordinate locations.
- **Location.** The tree's physical location in relation to public ROW and/or public space will be recorded.
- **Address**. DRG will identify the location of each street tree and planting site so that they can easily be identified for future maintenance work. Street trees and planting sites will be located using an address number, street name, side of address, and on street.
- **Species.** All palms will be identified by general term "Palm."

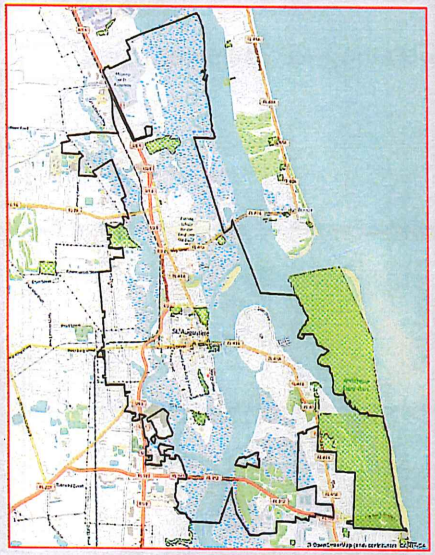
Urban Tree Canopy Assessment Method

The U.S. Forest Service developed the i-Tree Canopy tool to allows users to easily interpret Google Earth aerial imagery for areas of interest and produce statistical estimates of tree cover and other cover types. Calculation of estimate uncertainty is provided as well. This tool provides a quick and inexpensive means for communities and forest managers to accurately estimate their tree canopy cover.



APPENDIX B
INVENTORY MAPS

City of St Augustine
Tree Inventory



Legend

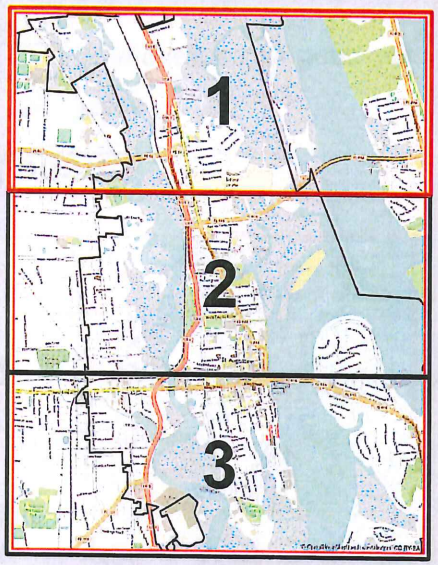
- Trees
- St Augustine City Boundary
- Parks

0 2,500 Feet

DAVEY RESOURCE GROUP
A Division of The Davey Tree Expert Company

Tree Inventory Date: July 11, 2017 - July 19, 2017
Project Coordinate System: NAD 83 UTM Zone 18N. Meters
Data Source: City of St Augustine, Davey Resource Group

City of St Augustine
Tree Inventory
Section 1



Legend

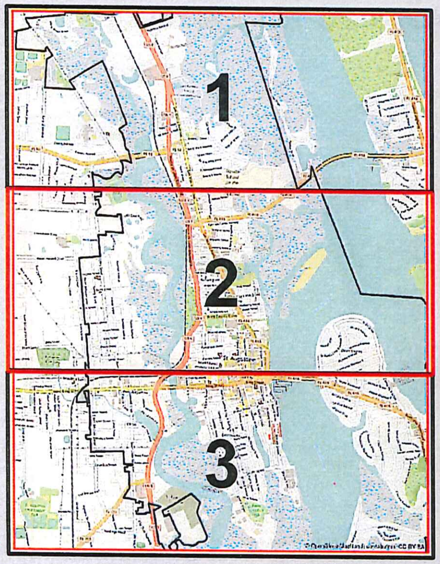
- Trees
- St Augustine City Boundary
- Parks

0 1,500 Feet

DAVEY RESOURCE GROUP
A Division of The Davey Tree Expert Company

Tree Inventory Date: July 11, 2017 - July 19, 2017
Project Coordinate System: NAD 83 UTM Zone 18N. Meters
Data Source: City of St Augustine, Davey Resource Group

City of St Augustine Tree Inventory Section 2



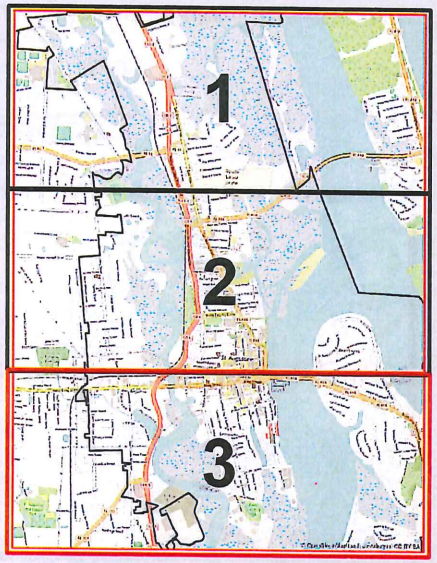
Legend

- Trees
- St Augustine City Boundary
- Parks

0 1,500 Feet

Tree Inventory Date: July 11, 2017 - July 19, 2017
Project Coordinate System: NAD 83 UTM Zone 18N. Meters
Data Source: City of St Augustine, Davey Resource Group

City of St Augustine
Tree Inventory
Section 3



Legend

- Trees
- St Augustine City Boundary
- Parks

0 1,500 Feet

DAVEY RESOURCE GROUP
A Division of The Davey Tree Expert Company

Tree Inventory Date: July 11, 2017 - July 19, 2017
Project Coordinate System: NAD 83 UTM Zone 18N. Meters
Data Source: City of St Augustine, Davey Resource Group

APPENDIX C
PESTS AND DISEASES THAT AFFECT TREES IN FLORIDA

The following sections describe some of the key pests and diseases discussed in this report that can adversely affect the trees in Florida at the time of this plan's development. Note that this list is not comprehensive and does not include all threats.

Bacterial Leaf Scorch

The bacterium for bacterial leaf scorch (BLS, *Xylella fastidiosa*) is spread primarily by xylem-feeding insects and also grafting. Once present, the bacterium multiply and colonize in the xylem, blocking transport of water to plant tissue. The tree's reaction to the bacterium causes further blocked transport leading to ultimate fatality.

Presence of BLS has been found in states from New York to Texas, and in Washington, DC, California, Indiana, Kentucky, Nebraska, and Ohio. It causes a premature need for removal due to unsightly or unsafe results of the disease. No cure or preventative measures are currently known once it is present.

Known hosts for BLS include *Catalpa* spp. (catalpa), *Ulmus americana* (America elm), *Ginkgo* spp. (ginkgo), *Celtis* spp. (hackberry), maple, *Morus* spp. (mulberry), *Quercus* spp.(oak), *Platanus* spp. (sycamore), and *Liquidambar* spp. (sweetgum).

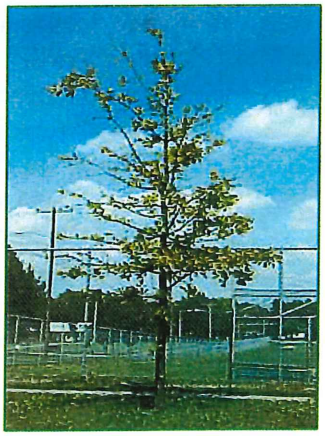
Bacterial Leaf Scorch symptoms on elm leaves.

Photograph courtesy Jo-Ann Bentz, The United States National Arboretum.

Chlorosis

Foliage that lacks chlorophyll production will turn yellow and become chlorotic, or have symptoms of chlorosis. Lack of chlorophyll impedes the plant's ability to convert sugars to energy and grow. This can be the result of many different factors or various nutrient deficiencies, including compacted soil, damaged roots, high pH or alkaline soils, nutrient deficiencies, and poor drainage. Nutrient deficiency may be the result of low quantity in the soil, or low availability due to pH. There can be various patterns of yellowing on the leaves as a result of the different causes.

Lack of iron is a common nutrient deficiency causing chlorosis, followed by manganese and zinc. As pH rises, iron becomes less soluble and, therefore, less available for uptake through the roots, although there can be other reasons for a tree to lack iron as well. For many plants, the ideal pH level for iron uptake is between 5.0 and 6.5. A soil test for pH and presence of necessary nutrients in the soil can be done to determine proper corrective measures if necessary.



***Quercus palustris* (pin oak) with severe iron chlorosis.**

Photograph courtesy of Utah State University Extension Services.

Depending on the cause of chlorosis, there may be different treatments. Core aerification, mulching, tiling, or other practices may alleviate stresses from poor drainage, soil compaction, or possibly root injury. Nutrient deficiency can be treated through foliar application of water-soluble or chelated nutrients, but trunk or soil applications will have longer lasting results.

Croton Scale

Croton scale *(Phalacrococcus howertoni)* was first noted in Florida in 2008. The soft scale can be found on the underside of leaves and small stems of many species of plants in Florida, including croton, gumbo limbo, firebush, strangler fig, guava, and wild coffee.

The insect pierces and sucks out substance from leaves and stems, and left uncontrolled it can kill the plant. Symptoms of infestation include a slow decline and later defoliation, but the more obvious sign of scale is the resulting black "sooty mold" that occurs when "honeydew" excreted from the insects molds and blackens nearby surfaces.

Treatment can be effective if caught early, timed correctly and, if possible, combined with pruning out heavily infested sections.

Croton scale infestation.
Photograph courtesy of IFAS

Ganoderma Butt Rot

A serious fungal disease affecting mature palms, Ganoderma butt rot (caused by the *Ganoderma zonatum* fungus) was first identified in south Florida by scientists in 1994. It is a lethal and incurable disease. Few, if any, palms are resistant.

Older fronds will wither, turn brown, and droop while new growth slows and becomes pale green/yellow. Infected trees should be removed upon detection of this disease to avoid spreading and trunks should be burned to destroy the fungus. The disease is often spread through floating spores from conks (mushrooms) present at the base of the tree, through the spread of spores on pruning tools, or through mulch from the tree if it is ground up after. Do not replant palms in the same site as fungus will remain in the soil.

Sabal palm showing signs of Ganoderma butt rot.
Photograph courtesy of IFAS.

Hypoxylon Cankers

Cankers, or rotted depressions in a tree's trunk from disease, affect *Quercus* spp. (oaks) in Florida. Cankers often emerge as a secondary problem to a larger issue. When an oak is already stressed from lack of water, root disease, soil compaction, construction damage, etc., *Hypoxylon* cankers caused by fungi (*Hypoxylon* sp.) can occur (in oaks and other hardwoods) and are often the final blow leading to tree death.

Heavily infested trees are typically considered beyond treatment. Trees with lesser infections can have the infections carefully pruned out to lessen the spread to the rest of the tree.

***Hypoxylon* Cankers**
Photograph courtesy of IFAS

Fusarium Wilt

Mexican fan palm showing signs of Fusarium wilt.
Photograph courtesy of IFAS.

Fusarium wilt (caused by the *Fusarium oxysporum* sp. *Palmarum* fungus) affects primarily *Syagrus romanzoffianum* (queen palm) and *Washingtonia robusta* (Mexican fan palm). There is no remedy or cure, and infected palms should be removed immediately and a new different species planted in its place.

The disease acts extremely fast and will kill the palm within a few months. Symptoms include yellowing of fronds on one side, usually starting with the oldest first, then moving upward.

The disease spreads by spores blown in the wind or, more commonly, via contaminated pruning tools.

Whiteflies

Two whitefly species are present and worth noting in Florida: ficus whitefly (*Singhiella simplex*) and Rugose spiraling whitefly (*Aleurodicus rugioperculatus*).

The ficus whitefly, also known as fig whitefly, is native to Asia and was detected in Florida in August 2007. It affects primarily only ficus plant species, including *Ficus aurea* (strangler fig) and *F. benjamina* (weeping fig). Initial damage includes yellowing of leaves followed by leaf drop, branch dieback, and defoliation in severe infestations. Repeated re-growth and defoliation can reduce overall plant health (Mannion et al. 2012).

Ficus hedge damage from ficus whitefly and the underside of leaf showing silvery-white tiny spots (sign of infestation). Photograph courtesy of IFAS.

Often referred to as the gumbo-limbo spiraling whitefly, the Rugose spiraling whitefly is an invasive pest from Central America that was first found in Miami-Dade County in 2009.

Unlike the ficus whitefly (which is restricted to plants within the ficus genus), the spiraling whitefly infests over 90 plant species. The most common plant hosts include banana (in the Musa genus), *Bucida buceras* (black olive), *Bursera simaruba* (gumbo limbo), *Calophyllum* spp. (calophyllum), *Cocos nucifera* (coconut palm), *Helconia* spp. (bird of paradise), *Mangifera indica* (mango), and *Persea americana* (avocado) (IFAS 2012). However, while the ficus whitefly can be deadly, the spiraling whitefly usually causes only aesthetic problems in most cases.

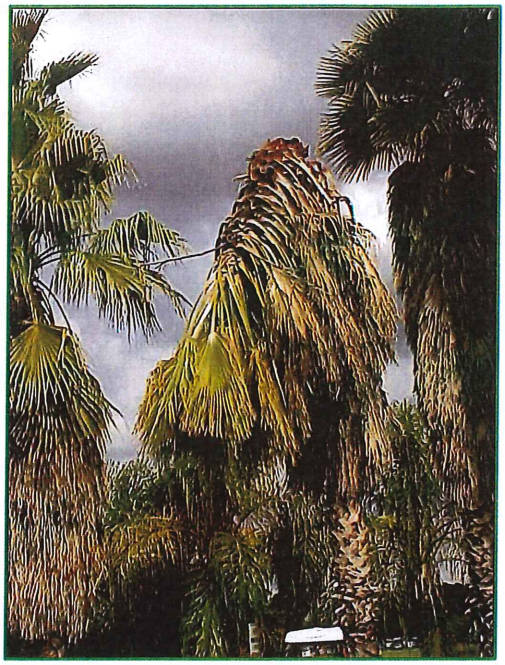
Infestations can become extremely dense and symptoms are hard to miss with the underside of leaves covered with a white, waxy substance often in a spiral form and the leaf tops blackened by "sooty mold." This black mold often covers everything around it, including cars, houses, sidewalks, etc. (IFAS 2012).

Close-up of Rugose spiraling whitefly and the resultant waxy covering on the underside of fronds. Photographs courtesy of IFAS (flwhitefly.org).

Thielaviopsis Trunk Rot

Thielaviopsis trunk rot is a disease caused by the *Thielaviopsis paradoxa* fungus. It infects the trunk of palms through fresh trunk wounds and eventually eats away at the structure of the palm. Unfortunately, there often are no visible signs that a palm is infected until either the trunk collapses on itself or the canopy suddenly falls off the trunk completely.

There are no known cures for this disease. The diseased palm should be removed immediately and debris destroyed.



Trunk rot collapse on Mexican fan palm. Photograph courtesy of IFAS

POTENTIAL INVASIVE PESTS AND DISEASES

In today's worldwide marketplace, the volume of international trade brings increased potential for pests and diseases to invade our country. Many of these pests and diseases have seriously harmed rural and urban landscapes and have caused billions of dollars in lost revenue and millions of dollars in clean-up costs. Keeping these pests and diseases out of the country is the number one priority of the United States Department of Agriculture's (USDA) Animal and Plant Inspection Service (APHIS).

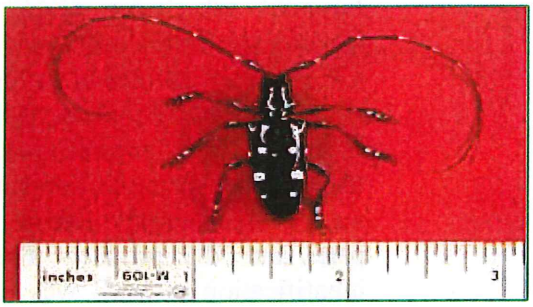
Although some invasive species naturally enter the United States via wind, ocean currents, and other means, most invasive species enter the country with some help from human activities. Their introduction to the U.S. is a byproduct of cultivation, commerce, tourism, and travel. Many species enter the United States each year in baggage, cargo, contaminants of commodities, or mail.

Once they arrive, hungry pests grow and spread rapidly because controls, such as native predators, are lacking. Invasive pests disrupt the landscape by pushing out native species, reducing biological diversity, killing trees, altering wildfire intensity and frequency, and damaging crops. Some pests may even push species to extinction. The following sections include key pests and diseases that adversely affect trees in America at the time of this plan's development. This list is not comprehensive and may not include all threats.

It is critical to the management of community trees to routinely check APHIS, USDA Forest Service, and other websites for updates about invasive species and diseases in your area and in our country so that you can be prepared to combat their attack.

Asian Longhorned Beetle

The Asian longhorned beetle (ALB, *Anoplophora glabripennis*) is an exotic pest that threatens a wide variety of hardwood trees in North America. The beetle was introduced in Chicago, New Jersey, and New York City, and is believed to have been introduced in the United States from wood pallets and other wood-packing material accompanying cargo shipments from Asia. ALB is a serious threat to America's hardwood tree species.



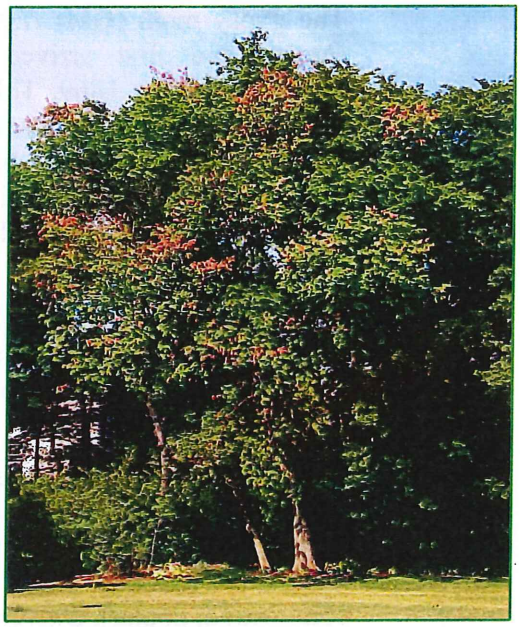
Adult Asian longhorned beetle

Photograph courtesy of New Bedford Guide 2011

Adults are large (3/4- to 1/2-inch long) with very long, black and white banded antennae. The body is glossy black with irregular white spots. Adults can be seen from late spring to fall depending on the climate. ALB has a long list of host species; however, the beetle prefers hardwoods, including several maple species. Examples include: *Acer negundo* (box elder); *A. platanoides* (Norway maple); *A. rubrum* (red maple); *A. saccharinum* (silver maple); *A. saccharum* (sugar maple); *Aesculus glabra* (buckeye); *A. hippocastanum* (horsechestnut), *Betula* (birch), *Platanus* × *acerifolia* (London planetree), *Salix* (willow), and *Ulmus* (elm).

Dutch Elm Disease

Considered by many to be one of the most destructive, invasive diseases of shade trees in the United States, Dutch elm disease (DED) was first found in Ohio in 1930; by 1933, the disease was present in several East Coast cities. By 1959, it had killed thousands of elms. Today, DED covers about two-thirds of the eastern United States, including Illinois, and annually kills many of the remaining and newly planted elms. The disease is caused by a fungus that attacks the vascular system of elm trees blocking the flow of water and nutrients, resulting in rapid leaf yellowing, tree decline, and death.



Branch death, or flagging, at multiple locations in the crown of a diseased elm

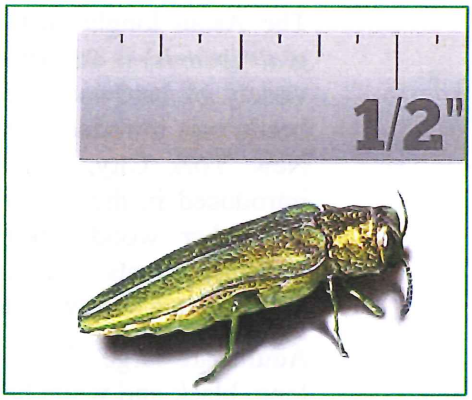
Photograph courtesy of Steven Katovich, USDA Forest Service, Bugwood.org (2011)

There are two closely-related fungi that are collectively referred to as DED. The most common is *Ophiostoma novo-ulmi*, which is thought to be responsible for most of the elm deaths since the 1970s. The fungus is transmitted to healthy elms by elm bark beetles. Two species carry the fungus: native elm bark beetle (*Hylurgopinus rufipes*) and European elm bark beetle (*Scolytus multistriatus)*.

The species most affected by DED is the *Ulmus americana* (American elm).

Emerald Ash Borer

Emerald ash borer *(EAB) (Agrilus planipennis*) is responsible for the death or decline of tens of millions of ash trees in 14 states in the American Midwest and Northeast. Native to Asia, EAB has been found in China, Japan, Korea, Mongolia, eastern Russia, and Taiwan. It likely arrived in the United States hidden in wood-packing materials commonly used to ship consumer goods, auto parts, and other products. The first official United States identification of EAB was in southeastern Michigan in 2002.



Close-up of the emerald ash borer

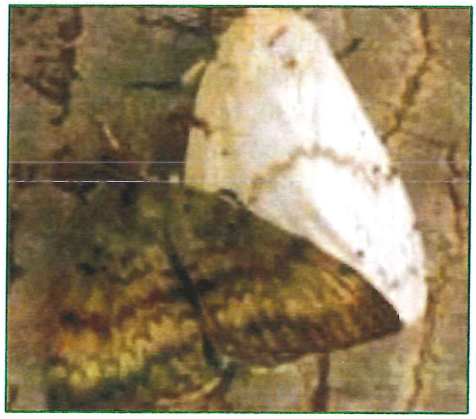
Photograph courtesy of APHIS (2011)

Adult beetles are slender and 1/2-inch long. Males are smaller than females. Color varies but adults are usually bronze or golden green overall with metallic, emerald-green wing covers. The top of the abdomen under the wings is metallic, purplish-red and can be seen when the wings are spread.

The EAB-preferred host tree species are in the genus *Fraxinus* (ash).

Gypsy Moth

The gypsy moth (GM) *(Lymantria dispar*) is native to Europe and first arrived in the United States in Massachusetts in 1869. This moth is a significant pest because its caterpillars have an appetite for more than 300 species of trees and shrubs. GM caterpillars defoliate trees, which makes the species vulnerable to diseases and other pests that can eventually kill the tree.



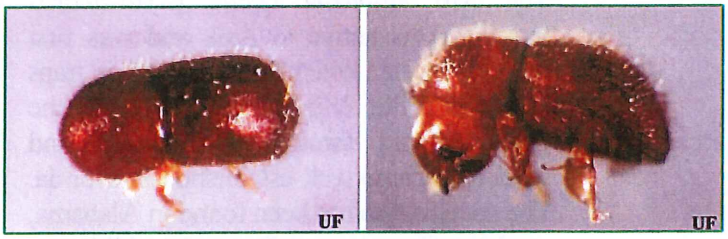
Close-up of male (darker brown) and female (whitish color) European gypsy moths

Photograph courtesy of APHIS (2011b)

Male GMs are brown with a darker brown pattern on their wings and have a 1/2-inch wingspan. Females are slightly larger with a 2-inch wingspan and are nearly white with dark, saw-toothed patterns on their wings. Although they have wings, the female GM cannot fly.

The GMs prefer approximately 150 primary hosts but feed on more than 300 species of trees and shrubs. Some trees are found in these common genera: *Betula* (birch), *Juniperus* (cedar), *Larix* (larch), *Populus* (aspen, cottonwood, poplar), *Quercus* (oak), and *Salix* (willow).

Granulate Ambrosia Beetle



Adult granulate ambrosia beetle

Photograph courtesy of Paul M. Choate, University of Florida (Atkinson et al. 2011)

The granulate ambrosia beetle (*Xylosandrus crassiusculus*), formerly the Asian ambrosia beetle, was first found in the United States in 1974 on peach trees near Charleston, South Carolina. The native range of the granulate ambrosia beetle is probably tropical and subtropical Asia. The beetle is globally present in countries such as equatorial Africa, Asia, China, Guinea, Hawaii, India, Japan, New South Pacific, Southeast Indonesia, Sri Lanka, and the United States. In the United States, this species has spread along the lower Piedmont region and coastal plain to East Texas, Florida, Louisiana, and North Carolina. Populations were found in Oregon and Virginia in 1992, and in Indiana in 2002.

Adults are small and have a reddish-brown appearance with a downward facing head. Most individuals have a reddish head region and a dark-brown to black elytra (hard casings protecting the wings). Light-colored forms that appear almost yellow have also been trapped. A granulated (rough) region is located on the front portion of the head and long setae (hairs) can be observed on the back end of the wing covers. Females are 2–2.5mm and males are 1.5mm long. Larvae are C-shaped with a defined head capsule.

The granulate ambrosia beetle is considered an aggressive species and can attack trees that are not highly stressed. It is a potentially serious pest of ornamentals and fruit trees and is reported to be able to infest most trees and some shrubs (azalea, rhododendron) but not conifers. Known hosts in the United States include: *Acer* (maple); *Albizia* (albizia); *Carya* (hickory); *Cercis canadensis* (eastern redbud); *Cornus* (dogwood); *Diospyros* (persimmon); *Fagus* (beech); *Gleditsia* or *Robinia* (locust); *Juglans* (walnut); *Koelreuteria* (goldenrain tree); *Lagerstroemia* (crapemyrtle); *Liquidambar styraciflua* (sweetgum); *Liriodendron tulipifera* (tulip poplar); *Magnolia* (magnolia); *Populus* (aspen); *Prunus* (cherry); *Quercus* (oak); and *Ulmus parvifolia* (Chinese elm). *Carya illinoinensis* (pecan) and *Pyrus calleryana* (Bradford pear) are commonly attacked in Florida and in the southeastern United States.

Xm Ambrosia Beetle

Xm ambrosia beetle

Photograph courtesy of Michael C. Thomas, Florida Department of Agriculture and Consumer Services (Rabaglia et al 2003)

The Xm ambrosia beetle (*Xylosandrus mutilatus*), is native to Asia and was first detected in the United States in 1999 in traps near Starkville, Mississippi. By 2002, the beetle spread throughout Missouri and quickly became well-established in Florida. The species also has been found in Alabama, northern Georgia, and Texas. In addition to its prevalence in the southeastern United States, the Xm ambrosia beetle is currently found in China, India, Indonesia, Japan, Korea, Malaya, Myanmar, Papua New Guinea, Sri Lanka, Taiwan, and Thailand.

This species generally targets weakened and dead trees. Since the beetle attacks small diameter material, it may be commonly transported in nursery stock. Female adults are prone to dispersal by air currents and can travel 1–3 miles in pursuit of potential hosts. This active capability results in a broad host range and high probability of reproduction. The species is larger than any other species of *Xylosandrus* (greater than 3 millimeters) in the U.S. and is easily recognized by its steep declivity and dark brown to black elytra (hard casings protecting the wings). Larvae are white and c-shaped with an amber colored head capsule.

Known hosts in the U.S. include: *Acer* (maple); *Albizia* (silktree); *Benzoin* (northern spicebush); *Camellia* (camellia); *Carpinus laxiflora* (looseflower hornbeam); *Castanae* (sweet chestnut); *Cinnamomum camphora* (camphor tree); *Cornus* (dogwood); *Cryptomeria japonica* (Japanese cedar); *Fagus crenata* (Japanese beech); *Lindera erythrocarpa* (spicebush); *Machilus thurnbergii* (Japanese persea); *Ormosia hosiei* (ormosia); *Osmanthus fragrans* (sweet osmanthus); *Parabezion praecox*; *Platycarpa*; and *Sweitenia macrophylla* (mahogany).

Oak Wilt

Oak wilt symptoms on red and white oak leaves

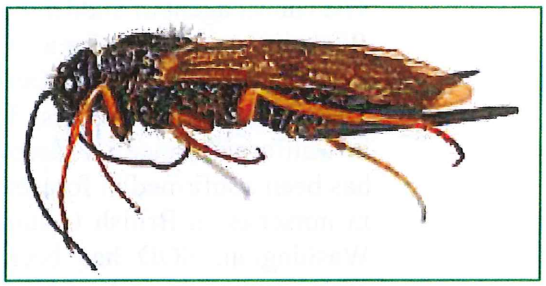
Photograph courtesy of USDA Forest Service (2011a)

Oak wilt was first identified in 1944 and is caused by the fungus *Ceratocystis fagacearum*. While considered an invasive and aggressive disease, its status as an exotic pest is debated since the fungus has not been reported in any other part of the world. This disease affects the oak genus and is most devastating to those in the red oak subgenus, such as *Quercus coccinea* (scarlet oak), *Q. imbricaria* (shingle oak), *Q. palustris* (pin oak), *Q. phellos* (willow oak), and *Q. rubra* (red oak). It also attacks trees in the white oak subgenus, although it is not as prevalent and spreads at a much slower pace in these trees.

Just as with DED, oak wilt disease is caused by a fungus that clogs the vascular system of oaks and results in decline and death of the tree. The fungus is carried from tree to tree by several borers common to oaks, but the disease is more commonly spread through root grafts. Oak species within the same subgenus (red or white) will form root colonies with grafted roots that allow the disease to move readily from one tree to another.

Sirex Woodwasp

Sirex woodwasp (*Sirex noctillio*) has been the most common species of exotic woodwasp detected at United States ports-of-entry associated with solid wood-packing materials. Recent detections of sirex woodwasp outside of port areas in the United States have raised concerns because this insect has the potential to cause significant mortality of pines. Awareness of the symptoms and signs of a sirex woodwasp infestation increases the chance of early detection, thus increasing the rapid response needed to contain and manage this exotic forest pest.



Close-up of female Sirex Woodwasp

Photograph courtesy of USDA (2005)

Woodwasps (or horntails) are large robust insects, usually 1.0 to 1.5 inches long. Adults have a spear-shaped plate (cornus) at the tail end; in addition, females have a long ovipositor under this plate. Larvae are creamy white, legless, and have a distinctive dark spine at the rear of the abdomen. More than a dozen species of native horntails occur in North America.

Sirex woodwasps can attack living pines, while native woodwasps attack only dead and dying trees. At low populations, sirex woodwasp selects suppressed, stressed, and injured trees for egg laying. Foliage of infested trees initially wilts, and then changes color from dark green to light green, to yellow, and finally to red, during the three to six months following attack. Infested trees may have resin beads or dribbles at the egg laying sites, but this is more common at the mid-bole level. Larval galleries are tightly packed with very fine sawdust. As adults emerge, they chew round exit holes that vary from 1/8 to 3/8 inch in diameter.

Southern Pine Beetle

The southern pine beetle (SPB, *Dendroctonus frontalis*) is the most destructive insect pest of pine in the southern United States. It attacks and kills all species of southern yellow pines including *P. strobus* (eastern white pine). Trees are killed when beetles construct winding, S-shaped egg galleries underneath the bark. These galleries effectively girdle the tree and destroy the conductive tissues that transport food throughout the tree. Furthermore, the beetles carry blue staining fungi on their bodies that clog the water conductive tissues (wood), which transport water within the tree. Signs of attack on the outside of the tree are pitch tubes and boring dust, known as frass, caused by beetles entering the tree.

Adult southern pine beetles

Photograph courtesy of Forest Encyclopedia Network (2012)

Adult SPBs reach an ultimate length of only 1/8 inch, similar in size to a grain of rice. They are short-legged, cylindrical, and brown to black in color. Eggs are small, oval-shaped, shiny, opaque, and pearly white.

Sudden Oak Death

The causal agent of sudden oak death (SOD, also known as *Phytophthora* canker disease), *Phytophthora ramorum*, was first identified in 1993 in Germany and the Netherlands on ornamental rhododendrons. In 2000, the disease was found in California. Since its discovery in North America, SOD has been confirmed in forests in California and Oregon and in nurseries in British Columbia, California, Oregon, and Washington. SOD has been potentially introduced into other states through exposed nursery stock. Through ongoing surveys, APHIS continues to define the extent of the pathogen's distribution in the United States and limit its artificial spread beyond infected areas through quarantine and a public education program.

Drooping tanoak shoot

Photograph courtesy of Indiana Department of Natural Resources (2012)

Identification and symptoms of SOD may include large cankers on the trunk or main stem accompanied by browning of leaves. Tree death may occur within several months to several years after initial infection. Infected trees may also be infested with ambrosia beetles (*Monarthrum dentiger* and *M. scutellarer*), bark beetles (*Pseudopityophthorus pubipennis*), and sapwood rotting fungus (*Hypoxylon thouarsianum*). These organisms may contribute to the death of the tree. Infection on foliar hosts is indicated by dark grey to brown lesions with indistinct edges. These lesions can occur anywhere on the leaf blade, in vascular tissue, or on the petiole. Petiole lesions are often accompanied by stem lesions. Some hosts with leaf lesions defoliate and eventually show twig dieback.

This pathogen is devastating to *Quercus* (oaks) but also affects several other plant species.

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APPENDIX D
RECOMMENDED SPECIES LIST

Canopy Trees

Botanical Name	Common Name	USDA Hardiness Zone	Native to North Florida?	Street Tree?	Drought Tolerance	Soil Salt Tolerance	Salt Spray Tolerance	Wind Resistance	Soil pH	Pest Resistance	Mature Spread (feet)	Mature Height (feet)	Growth Rate
Acer rubrum	red maple		Yes	Yes	Low	Low	Low	Susceptible	AC	Susceptible	25-35	60-75	Fast
Betula nigra	river birch		Yes	Yes	Low	Low	Low	Resistant	AC	Resistant	25-35	40-50	Fast
Carya aquatica	water hickory		Yes	No	Low	Low	Low	Resistant	SLALK to AC	Resistant	25-50	60-85	Slow
Carya glabra	pignut hickory		Yes	No	High	Low	Low	Resistant	SLALK to AC	Resistant	30-50	50-75	Fast
Carya illinoinensis	pecan		Yes	No	High	Very Low	None	Susceptible	ALK to AC	Susceptible	50-70	70-100	Moderate
Celtis laevigata	sugarberry		Yes	Yes	High	High	High	Susceptible	ALK to AC	Resistant	50-60	50-70	Fast
Chamaecyparis thyoides	Atlantic whitecedar		Yes	No	Low	Low	Low	Resistant	AC	Resistant	10-20	40-50	Slow
Diospyros virginiana	common persimmon		Yes	No	Moderate	High	High	Resistant	ALK to AC	Susceptible	20-35	40-60	Moderate
Ilex opaca	American holly		Yes	Yes	Moderate	Moderate	Moderate	Resistant	SLALK to AC	Resistant	15-25	35-50	Slow
Juniperus silicicola	southern redcedar		Yes	Yes	High	Moderate	Moderate	Susceptible	ALK to AC	Resistant	25-35	20-40	Moderate
Koelreuteria bipinnata	Chinese flametree		No	Yes	High	Moderate	Moderate	Susceptible	ALK to AC	Susceptible	25-35	20-35	Fast
Koelreuteria paniculata	golden raintree		No	Yes	High	Moderate	Moderate	Resistant	ALK to AC	Susceptible	30-40	30-40	Moderate
Liquidambar styraciflua	Rotundiloba American		Yes	No	High	Moderate	Moderate	Resistant	SLALK to AC	Resistant	35-45	50-70	Fast
Liriodendron tulipifera	tuliptree		Yes	Yes	Low	None	None	Resistant	AC	Resistant	30-50	80-100	Fast
Magnolia grandiflora	southern magnolia		Yes	Yes	High	High	High	Resistant	SLALK to AC	Resistant	30-40	60-80	Moderate
Nyssa sylvatica	black tupelo		Yes	Yes	Low	Moderate	Moderate	Resistant	AC	Resistant	25-35	65-75	Slow
Pinus clausa	sand pine		Yes	No	High	Moderate	Moderate	Susceptible	SLALK to AC	Resistant	15-30	30-50	Slow
Pinus elliottii	slash pine		Yes	No	High	High	High	Susceptible	SLALK to AC	Susceptible	35-50	75-100	Fast
Pinus glabra	spruce pine		Yes	No	Low	Low	Low	Resistant	SLALK to AC	Resistant	25-40	30-60	Slow
Pinus palustris	longleaf pine		Yes	No	High	High	High	Resistant	SLALK to AC	Resistant	30-40	60-80	Moderate
Pinus serotina	pond pine		Yes	No	Moderate	Low	Low	Resistant	AC	Resistant	15-30	30-50	Moderate
Pinus taeda	loblolly pine		Yes	No	High	Moderate	Moderate	Susceptible	AC	Resistant	30-35	50-80	Moderate
Platanus occidentalis	American sycamore		Yes	Yes	Low	Moderate	Moderate	Resistant	ALK to AC	Susceptible	50-70	75-90	Fast
Podocarpus macrophyllus	podocarpus		No	Yes	High	High	High	Resistant	ALK to AC	Resistant	20-25	30-40	Slow
Podocarpus nagi	nagi podocarpus		No	Yes	High	Moderate	Moderate	Resistant	ALK to AC	Resistant	15-25	30-50	Moderate
Quercus acutissima	sawtooth oak		No	Yes	High	Moderate	Moderate	Resistant	SLALK to AC	Resistant	35-50	35-45	Moderate
Quercus austrina	bluff oak		Yes	Yes	High	Unknown	Unknown	Resistant	AC	Resistant	35-50	40-60	Moderate
Quercus falcata	southern red oak		Yes	Yes	High	Moderate	Moderate	Resistant	AC	Resistant	60-70	60-80	Moderate
Quercus geminata	sand live oak		Yes	Yes	High	High	High	Resistant	AC	Resistant	35-50	30-60	Moderate
Quercus laurifolia	laurel oak		Yes	Yes	High	Low	Low	Susceptible	SLALK to AC	Resistant	35-45	60-70	Fast
Quercus michauxii	swamp chestnut oak		Yes	Yes	Low	None	None	Resistant	AC	Resistant	60-70	40-100	Moderate
Quercus montana	chestnut oak		Yes	Yes	High	Unknown	Unknown	Resistant	SLALK to SLAC	Resistant	40-60	50-60	Moderate
Quercus nigra	water oak		Yes	No	High	Low	Low	Susceptible	ALK to AC	Resistant	60-70	50-60	Fast
Quercus pagoda	cherrybark oak		Yes	Yes	High	Moderate	Moderate	Resistant	AC	Resistant	60-70	60-80	Moderate
Quercus phellos	willow oak		Yes	Yes	High	High	High	Resistant	AC	Resistant	40-50	60-75	Fast
Quercus shumardii	Shumard oak		Yes	Yes	Moderate	Moderate	Moderate	Resistant	ALK to AC	Resistant	40-50	55-80	Slow
Quercus virginiana	southern live oak		Yes	Yes	High	High	High	Resistant	ALK to AC	Resistant	60-120	60-80	Moderate
Taxodium ascendens	pondcypress		Yes	Yes	High	Moderate	Moderate	Resistant	SLALK to AC	Resistant	10-20	50-60	Moderate
Taxodium distichum	common baldcypress		Yes	Yes	High	Moderate	Moderate	Resistant	SLALK to AC	Resistant	25-35	60-80	Moderate
Ulmus alata	winged elm		Yes	Yes	High	Moderate	Moderate	Resistant	ALK to AC	Resistant	30-40	45-70	Fast
Ulmus parvifolia	Chinese elm		No	Yes	Moderate	Moderate	Moderate	Resistamt	ALK to AC	Susceptible	35-50	40-50	Moderate

Understory Trees

Botanical Name	Common Name	USDA Hardiness Zone	Native to North	Street Tree?	Drought Tolerance	Soil Salt Tolerance	Salt Spray Tolerance	Wind Resistance	Soil pH	Pest Resistance	Mature Spread (feet)	Mature Height (feet)	Growth Rate
Acer saccharum	Florida sugar maple		Yes	Yes	High	None	None	Resistant	AC	Resistant	20-30	20-40	Fast
Aesculus pavia	red buckeye		Yes	Yes	Moderate	Moderate	Moderate	Resistant	AC	Resistant	15-25	15-20	Moderate
Bumelia lanuginosa	chittamwood		Yes	No	High	Unknown	Unknown	Resistant	ALK to AC	Resistant	25-35	30-45	Moderate
Callistemon citrinus	red bottlebrush		No	Yes	High	Moderate	Moderate	Resistant	AC	Resistant	10-15	10-15	Moderate
Callistemon viminalis	weeping bottlebrush		No	Yes	High	Moderate	Moderate	Resistant	SLALK to AC	Resistant	15-20	15-20	Moderate
Carpinus caroliniana	American hornbeam		Yes	Yes	Low	None	None	Resistant	SLALK to AC	Resistant	20-30	20-30	Slow
Catalpa bignonioides	southern catalpa		Yes	No	High	Moderate	Moderate	Resistant	ALK to AC	Susceptible	35-45	30-40	Fast
Cercis canadensis	eastern redbud		Yes	Yes	High	None	None	Susceptible	ALK to AC	Susceptible	15-25	20-30	Moderate
Chionanthus retusus	Chinese fringetree		No	Yes	Moderate	Unknown	Unknown	Resistant	ALK to AC	Resistant	10-15	15-20	Slow
Chionanthus virginicus	white fringetree		Yes	Yes	Moderate	None	None	Resistant	AC	Resistant	10-15	12-20	Slow
Cornus drummondii	roughleaf dogwood		Yes	Yes	High	Low	Low	Resistant	ALK to AC	Resistant	10-15	15-25	Fast
Cornus florida	flowering dogwood		Yes	Yes	Moderate	Low	Low	Resistant	SLALK to AC	Susceptible	25-30	20-30	Moderate
xCupressocyparis leylandii	Leyland cypress		No	No	High	Moderate	Moderate	Resistant	ALK to AC	Susceptible	15-25	35-50	Fast
Eriobotrya japonica	loquat		No	No	Moderate	Moderate	Moderate	Resistant	ALK to AC	Susceptible	30-35	20-30	Moderate
Gordonia lasianthus	loblolly bay		Yes	No	Moderate	None	None	Resistant	AC	Resistant	10-15	30-40	Moderate
Ilex cassine	dahoon		Yes	Yes	Moderate	Moderate	Moderate	Resistant	SLALK to AC	Resistant	8-12	20-30	Moderate
Ilex vomitoria	yaupon holly		Yes	Yes	High	High	High	Resistant	SLAC	Resistant	15-20	15-25	Moderate
Jatropha integerrima	jatropha		No	No	Moderate	Moderate	Moderate	Resistant	ALK to AC	Resistant	10-15	10-15	Moderate
Lagerstroemia indica	common crapemyrtle		No	No	High	Unknown	Low	Resistant	SLALK to AC	Resistant	10-15	20-25	Moderate
Ligustrum japonicum	Japanese privet		No	Yes	Moderate	Moderate	High	Resistant	SLALK to AC	Resistant	8-12	15-25	Moderate

Understory Trees (Continued)

Botanical Name	Common Name	USDA Hardiness Zone	Native to North	Street Tree?	Drought Tolerance	Soil Salt Tolerance	Salt Spray Tolerance	Wind Resistance	Soil pH	Pest Resistance	Mature Spread (feet)	Mature Height (feet)	Growth Rate
Magnolia ashei	Ashe magnolia		No	Yes	Moderate	Unknown	Unknown	Resistant	SLALK to AC	Resistant	25-35	30-40	Moderate
Magnolia grandiflora	southern magnolia		Yes	Yes	High	Moderate	Moderate	Resistant	SLALK to AC	Resistant	15-30	30-45	Slow
Magnolia pyramidata	pyramid magnolia		No	No	Moderate	Moderate	Moderate	Resistant	SLALK to AC	Resistant	10-25	10-25	Moderate
Magnolia virginiana	sweetbay		Yes	Yes	Low	Low	Low	Resistant	AC	Resistant	15-25	40-50	Moderate
Morella cerifera	southern waxmyrtle		Yes	Yes	Moderate	Moderate	High	Susceptible	ALK to AC	Resistant	20-25	15-25	Moderate
Ostrya virginiana	eastern hophornbeam		Yes	Yes	High	None	None	Resistant	ALK to AC	Resistant	25-30	30-40	Slow
Oxydendron arboreum	sourwood		Yes	Yes	Moderate	Moderate	Moderate	Resistant	AC	Resistant	25-30	40-60	Slow
Planera aquatica	water elm		Yes	No	Low	Unknown	Unknown	Resistant	AC	Resistant	15-25	15-50	Slow
Platycladus orientalis	Oriental arborvitae		No	No	High	Low	Low	Resistant	AC	Resistant	10-15	15-20	Moderate
Prunus caroliniana	cherrylaurel		Yes	No	High	Moderate	Moderate	Resistant	SLALK to AC	Resistant	15-25	25-40	Moderate
Quercus acuta	Japanese evergreen oak		No	Yes	Moderate	Unknown	Unknown	Resistant	AC	Unknown	15-20	20-30	Moderate
Quercus chapmanii	Chapman oak		Yes	Yes	High	High	High	Resistant	SLALK to AC	Resistant	20-30	30-45	Slow
Quercus glauca	Japanese blue oak		No	Yes	High	Low	Low	Susceptible	AC	Resistant	25-35	25-40	Slow
Quercus incana	bluejack oak		Yes	Yes	High	Low	Low	Resistant	SLALK to AC	Resistant	10-20	20-30	Slow
Quercus laevis	turkey oak		Yes	No	High	Moderate	Moderate	Resistant	SLALK to AC	Resistant	15-30	40-50	Slow
Quercus myrtifolia	myrtle oak		Yes	No	High	Moderate	Moderate	Resistant	SLALK to AC	Resistant	10-20	10-25	Slow
Salix caroliniana	coastal plain willow		Yes	No	Low	Low	Low	Resistant	AC	Resistant	10-15	20-30	Fast
Sassafras albidum	sassafras		Yes	No	High	Low	Low	Resistant	AC	Resistant	25-40	30-60	Moderate
Stewartia malacodendron	silky stewartia		Yes	No	High	Low	Low	Resistant	AC	Resistant	8-12	10-20	Slow
Stewartia monadelpha	tall stewartia		No	No	High	Low	Low	Resistant	AC	Resistant	15-25	20-25	Slow
Styrax americanus	American snowbell		Yes	No	Low	Low	Low	Resistant	AC	Resistant	15-25	20-30	Moderate
Styrax grandifolius	bigleaf snowbell		Yes	No	Low	Low	Low	Resistant	AC	Resistant	15-25	20-30	Moderate
Symplocos tinctoria	sweetleaf		Yes	No	Low	Low	Low	Resistant	AC	Resistant	7-15	15-25	Moderate
Viburnum rufidulum	rusty blackhaw		Yes	Yes	High	None	None	Resistant	ALK to AC	Resistant	20-25	20-25	Slow
Zanthoxylum clava-herculis	Hercules-club		Yes	No	High	Moderate	Moderate	Resistant	ALK to AC	Resistant	10-15	25-30	Moderate

Palms

Botanical Name	Common Name	USDA Hardiness Zone	Native to North	Street Palm?	Drought Tolerance	Soil Salt Tolerance	Salt Spray Tolerance	Wind Resistance	Soil pH	Pest Resistance	Mature Spread (feet)	Mature Height (feet)	Growth Rate
Butia odorata	pindo palm	8-10B	No	No	High	Moderate	Low	Resistant	SLALK to AC	Resistant	10-15	15-25	Slow
Chamaedorea microspadix	hardy bamboo palm	8B-11	No	No	Moderate	Poor	Low	Resistant	SLALK to AC	Resistant	3-5	5-8	Slow
Chamaedorea radicalis	radicalis palm	8B-11	No	No	Moderate	Poor	Low	Resistant	SLALK to AC	Resistant	5-10	5-10	Slow
Chamaerops humilis	European fan palm	8-11	No	Yes	High	Poor	Moderate	Resistant	ALK to AC	Resistant	6-10	8-15	Slow
Howea forsteriana	kentia palm	9-11	No	Yes	Moderate	Moderate	Moderate	Resistant	SLALK to AC	Resistant	8-15	20-30	Slow
Livistona australis	Australian fan palm	9-11	No	Yes	High	Moderate	Moderate	Resistant	ALK to AC	Resistant	8-10	20-40	Slow
Livistona decipiens	ribbon fan palm	9-11	No	Yes	High	Moderate	Moderate	Resistant	ALK to AC	Resistant	10-12	20-30	Slow-Moderate
Livistona saribus	taraw palm	9-11	No	Yes	High	Moderate	Moderate	Resistant	ALK to AC	Resistant	10-15	40-60	Moderate
Livistonia chinensis	Chinese Fan Palm	9-11	No	Yes	High	Moderate	Moderate	Resistant	ALK to AC	Sensitive	10-12	15-25	Slow
Nannorrhops ritchiana	mazari palm	8-11	No	No	High	Unknown	Unknown	Resistant	ALK to AC	Slightly Sensitive	8-12	5-10	Slow
Phoenix canariensis	Canary Island date palm	8B-11	No	Yes	High	Moderate	Moderate	Resistant	ALK to AC	Sensitive	15-25	40-60	Slow
Phoenix dactylifera	Medjool date palm	8B-11	No	Yes	High	High	Moderate	Resistant	ALK to AC	Sensitive	12-15	50-80	Slow
Phoenix reclinata	Senegal date palm	9-11	No	No	High	Moderate	Moderate	Resistant	ALK to AC	Sensitive	12-20	25-35	Slow
Phoenix rupicola	cliff date palm	9-11	No	Yes	High	Moderate	Unknown	Resistant	ALK to AC	Slightly Sensitive	12-20	15-25	Slow
Phoenix sylvestris	toddy palm	8B-11	No	Yes	High	Moderate	Unknown	Resistant	ALK to AC	Resistant	15-25	25-50	Slow
Rhapidophyllum hystrix	needle palm	8-10B	Yes	No	High	Moderate	Low	Resistant	ALK to AC	Resistant	4-6	5-6	Slow
Rhapis excelsa	lady palm	9-11	No	No	Moderate	Moderate	Moderate	Resistant	ALK to AC	Resistant	10-15	5-7	Moderate
Sabal minor	dwarf palmetto	7-10B	Yes	No	High	Moderate	Moderate	Resistant	ALK to AC	Resistant	5-8	4-7	Slow
Sabal palmetto	sabal palm	8-11	Yes	Yes	High	High	High	Resistant	ALK to AC	Resistant	8-12	40-50	Slow
Serenoa repens	saw palmetto	8-11	Yes	No	High	High	High	Resistant	ALK to AC	Resistant	7-12	3-6	Slow
Trachycarpus fortunei	windmill palm	8-10B	No	Yes	High	Moderate	Moderate	Resistant	ALK to AC	Slightly Sensitive	5-15	10-20	Slow
Trithrinax acanthocoma	spiny fiber palm	9-11	No	Yes	High	Moderate	Moderate	Resistant	ALK to AC	Sensitive	5-10	10-15	Slow
Washingtonia robusta	Mexican fan palm	8-11	No	Yes	High	Moderate	High	Resistant	ALK to AC	Sensitive	6-15	50-100	Fast

APPENDIX E
PUBLIC ROUND TABLE MINUTES

CITY OF ST. AUGUSTINE

Urban Forestry Management Plan Roundtable

October 23, 2017

A Public Roundtable Discussion regarding the Urban Forestry Management Plan was held at the Galimore Center. The meeting was called to order at 9:00 a.m. by Martha Graham, and the following were present:

	Jenny Gulick, Davey Resource Group, Inc., Urban Forestry Consultant Craig Barzo, SALSA Melinda Rackoncay, St. Augustine Neighborhood Council Cash McVay, KRPG Bill Triay, University of Florida
Street Tree Advisory Committee:	Cathy Brown Gina Burrell Ann Derby Fremont Latimer Danny Lippi Peter Williams
City Staff:	Martha Graham, Public Works Director David Birchim, Director, Planning and Building Char Putz, Manager, Streets and Grounds Chris Anderson, Foreman II Streets and Grounds Robert Vanmierop, Code Enforcement Candice Seymour, Recording Secretary

Ms. Graham gave a brief introduction and the members at the table introduced themselves.

1. Discussion Regarding Urban Forestry Management Plan

Jenny Gulick began the discussion with a brief introduction including a project and master plan overview. She asked the panel and public for input to help customize the plan.

Ms. Gulick handed out a pamphlet detailing the street tree inventory and the following subjects were discussed regarding the inventory:

- Note that the survey was done prior to Hurricane Irma
- Criteria for street tree plantings
- Survey counted 3,000 street trees, including palms, but no condition or maintenance review was done for palm trees
- Fifty-seven species of trees found
- The need to inventory all public trees within the city limits; however, the statistics already gathered allowed the city to receive feedback regarding the health and variety of trees
- Possible recommendations for plant healthcare
- Concern for the dismissal of palms, especially since they comprise over 50% of urban trees
- Breakdown of types of oaks included in survey
- Risk assessments for trees included in data
- Level II inspections only, inventory noted whether further inspection was needed
- Overall tree canopy assessment considered fair with room for improvement
- Partnership with residence important to maintain canopies on private properties as well
- San Marco had very little room to plant trees, but smaller trees could be planted
- Tree Keeper® software to maintain updated inventory information through GIS, also a mobile ready program

- High-risk trees can be mitigated, but further assessment and data would be necessary with additional, trained staff
- Palms important canopy tree in Florida and would be considered viable option for planting
- Ensure replanting meets standards for correct planting to ensure long-term health of the trees
- Possibility of tree planting standards to be enforced
- Consideration of environmental changes in planting and replanting, including saltwater-tolerant plants to deal with saltwater intrusion
- Planting smaller trees to ensure future health of the tree and conserve resources
- Caution for enforcement of tree plantings on private property and possibility of community program to purchase and plant trees at lower costs to property owners
- Insurance did not always cover loss of trees
- Importance of community education regarding trees, planting, and maintenance
- Easiest to get funding for tree planting
- Possibility of asking CRA to help provide funding to remove unsafe or dead trees and assist in replanting

Ms. Gulick reviewed land-cover types and noted that the city had a low percentage of impervious pavement in comparison to other cities. She reviewed feedback from the public survey.

The panel discussed:

- Periodic tree-trimming by utility companies a potential problem for trees
- Survey response may not include developers, and potential push-back may come if ordinances were changed
- Good amount of feedback from the public 200/14,000

There was a brief discussion regarding collaborative plans between varying ownerships including the University of Florida and the State. There was recommendation of interlocal agreements for tree preservation and planting.

There was discussion regarding invasive species that did not require a permit.

Ms. Gulick facilitated a group activity which outlined the panel's opinions regarding the degree of varying resources, stakeholders, and management strategies.

There was discussion regarding strategies to enlist FPL in tree preservation with possibility of building tree plan into franchise agreement.

Discussion regarding staff incorporated the following topics:

- Largest problem because lack of staff causes public to lose vested interest in putting time into trees
- Implementation of master plan may lead to increased staffing depending upon budget and Commission decisions
- Needs within staff for decision-makers and/or sweat-labor
- Need for knowledgeable staff to aid in surveying and maintenance
- Volunteer management necessary
- Need to convince Commission to properly fund tree management and to find further funding for tree plan
- Developer based income not feasible for long-term funding
- In-house spending was estimated at $280,000 regarding tree maintenance
- Storms could put canopy cleaning and pruning behind schedule
- Possibility of utilizing Tourist Development dollars for tree maintenance
- FEMA did not reimburse for landscaping
- Giving public an option to allocate additional taxes into tree fund
- Funding for Nights of Lights
- Control of Mistletoe in the trees
- Strategies to engage stakeholders and raise funds
- Need for cost analysis to create budget
- Possibility of utilizing Neighborhood Association as holding company for funds

There was discussion regarding panel's vision for trees as follows:

- Hardening approach and make tree preservation a political issue
- Preferred list of canopy cover and street tree areas
- Benchmarks to improve the condition of trees over time
- Strengthen public profile with media regarding trees
- Notating historical trees
- Creating and distributing further educational material regarding invasive species and their impact on native trees: "Right Tree, Right Place"
- Get big-box retailers on board to cease selling invasive species and explain why

- More planting of young live oaks and identify locations that could support such plantings
- Following best practices made it difficult to plant live oaks and other large shade trees in the city
- Development of standard details to be included in the design manual to allow for shade trees
- May St and San Marco Ave intersection landscaping must be frangible trees per DOT requirements
- More education on utilizing palm trees for street canopy
- Plan placed in context of area ecology and salt intrusion

The following topics were discussed regarding the vision for players:

- Lincolnville CRA funding for dead tree removal to erase blight
- Test plan on Lincolnville area and expand what works to other neighborhoods
- Evaluating health of tree and fixing healthy trees with structural issues
- Timeframe for plan, short-term: 5 years, Mid-term: 10 years, Long term: 20 years with consistent reviews
- Sea level rise as a factor of decision-making
- Realizing that the proposed changes are for the long-term and will mainly affect future generations
- More school system involvement during Arbor Day
- Clearly identifying why stakeholders should be involved and how the changes mutually benefit all
- Recognition for private tree preservation and identifying and assisting in the preservation of heritage trees
- Educating homeowners regarding the value of heritage or specimen trees on their properties
- Utilizing neighborhood organizations for surveying and educating the public regarding trees
- Publicizing civic organization involvement in tree planting to raise awareness
- City could buy a surplus of trees and sell at a lower cost to residents along with education for proper planting

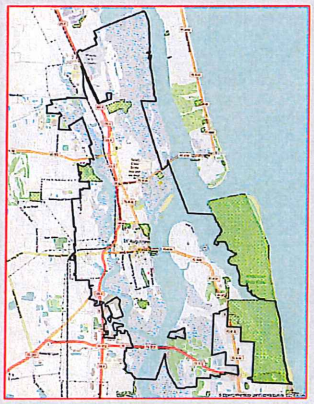
2. Adjournment

Having no further business, the meeting was adjourned at 12:02 p.m.[1]

[1] Transcribed by Candice Seymour

APPENDIX F
PLANTING SITE MAPS

City of St Augustine Planting Sites



Legend

- St Augustine City Boundary
- Parks

Planting Sites

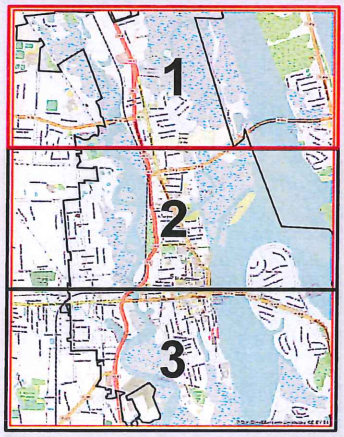
- Large
- Medium
- Small

0 2,000 Feet

DAVEY RESOURCE GROUP

Tree Inventory Date: July 11, 2017 - July 19, 2017
Project Coordinate System: NAD 83 UTM Zone 18N. Meters
Data Source: City of St Augustine, Davey Resource Group

City of St Augustine
Planting Sites
Section 1



Legend

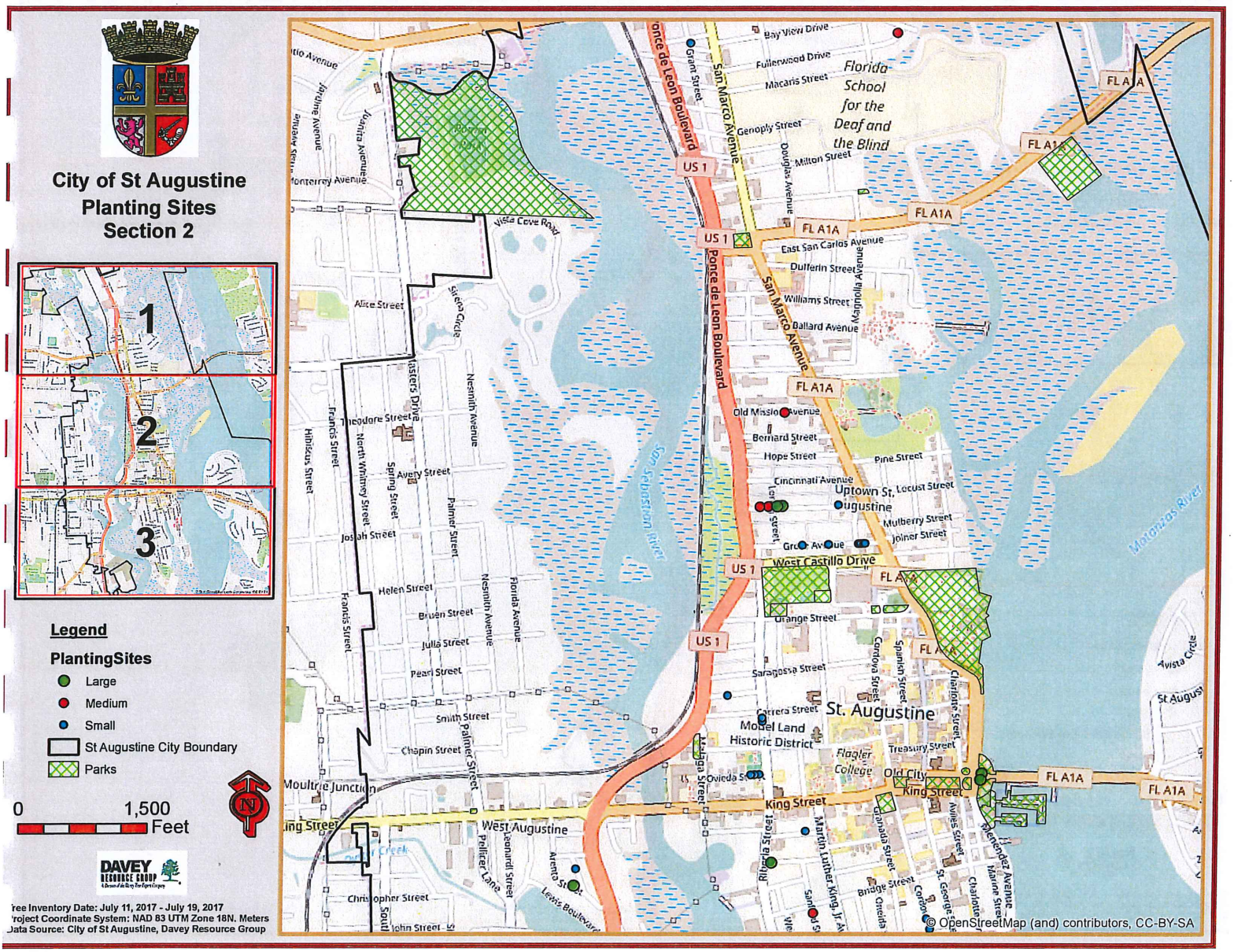
PlantingSites

- Large
- Medium
- Small
- St Augustine City Boundary
- Parks

0 1,500 Feet

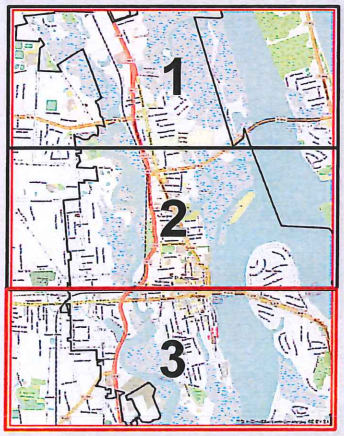
DAVEY RESOURCE GROUP

Tree Inventory Date: July 11, 2017 - July 19, 2017
Project Coordinate System: NAD 83 UTM Zone 18N. Meters
Data Source: City of St Augustine, Davey Resource Group



Tree Inventory Date: July 11, 2017 - July 19, 2017
Project Coordinate System: NAD 83 UTM Zone 18N. Meters
Data Source: City of St Augustine, Davey Resource Group

City of St Augustine
Planting Sites
Section 3



Legend

PlantingSites

- Large
- Medium
- Small

St Augustine City Boundary

Parks

0 1,500 Feet

DAVEY RESOURCE GROUP

Tree Inventory Date: July 11, 2017 - July 19, 2017
Project Coordinate System: NAD 83 UTM Zone 18N. Meters
Data Source: City of St Augustine, Davey Resource Group

APPENDIX G
APWA GUIDANCE POSITION STATEMENT

American Public Works Association
Washington Office
1401 K Street NW, 11th Floor
Washington DC 20005
202-408-9541/Fax202-408-9542

Guidance Position Statement

QUALITY MANAGEMENT OF THE URBAN FOREST

Statement of Purpose

The American Public Works Association (APWA), recognizing that the urban forest constitutes a vital public works infrastructure element, recommends that state, provincial, and local governments initiate programs that will enhance the quality of publicly maintained trees and related vegetation by adopting approved urban forest management standards.

Statement of Position

The APWA encourages public works agencies to maximize the environmental and quality of life benefits that the urban forest provides by:

- Utilizing the most current standards for planting, pruning, managing and preserving the urban forest.
- Incorporating tree canopy goals into community design standards.
- Identifying and meeting optimum mixed age and species distribution goals.
- Establishing reforestation practices that strategically address tree removals prior to the trees' decline.
- Coordinating the management of the urban forest with other agencies to minimize infrastructure conflicts.
- Preserving the integrity of remnant native forests.
- Recycling all green waste generated by urban forest management efforts.
- Maintaining active inventories of all urban forest assets.
- Obtaining political and stakeholder support that will ensure adequate funding for the long term care of the urban forest.

Background and Rationale

The urban forest is a significant and highly visual infrastructure system which provides a multitude of benefits to residents of urban, suburban and rural communities. Properly planned and managed, urban and community forests enrich our quality of life and environment by improving air and water quality, increasing property values, promoting

psychological and physical well-being, creating aesthetically pleasing neighborhoods, restoring wildlife habitat and building communities where people want to live.

The quality of life improvements and environmental benefits that urban and community forests provide to municipalities are fully realized when planning, design and management of the green infrastructure are integrated into the overall urban design and infrastructure management goals and strategies. Public and private agencies that impact the urban and community forest will maximize the benefits that trees bring to communities by adopting common goals and objectives.

Sponsor
Facilities and Grounds Committee