Urban Forest Resource Analysis
Tracy, CA

2019

TRACY

DAVEY
Resource Group

Urban Forest Resource Analysis
Tracy, California

2019

Prepared For:

City of Tracy
520 Tracy Blvd
Tracy, CA 95376
www.ci.tracy.ca.us

Prepared By:

Davey Resource Group, Inc.
6005 Capistrano Ave. Suite A
Atascadero, California 93422
Phone: 805-461-7500
Toll Free: 800-966-2021
Fax: 805-461-8501
www.davey.com/drg

Acknowledgements:

While the specific reports and recommendations can be attributed to this study, the basis for its structure and written content comes from the entire series of Municipal Forest Resource Analysis reports prepared and published by the USDA Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research, and credit should be given to those authors. The Municipal Forest Resource Analysis Reports are companions to the regional Tree Guides and i-Tree's Streets application developed by the USDA Forest Service, Pacific Southwest Research Station, Center for Public Urban Forest Research.

This project was made possible in part by grant funding from CAL FIRE.

Table of Contents

Tables

Figures

Executive Summary

Public trees play a vital role in Tracy. They provide numerous tangible and intangible benefits to residents, visitors, and neighboring communities. The City of Tracy recognizes that public trees are a valued resource, a critical component of the urban infrastructure, and part of the City's identity. As of 2018, the public tree inventory includes 35,561 trees.

In 2018, the City of Tracy contracted with Davey Resource Group (DRG) to complete an urban forest resource analysis to assess the structure and composition of the public tree inventory along with the benefits that the resource is providing. DRG used current inventory data in conjunction with i-Tree *Streets* benefit-cost modeling software to develop a detailed and quantified analysis of the current structure, function, and value of the community urban forest. This report details the results of that analysis.

Structure

A structural analysis is the first step towards understanding the benefits provided by the public trees, as well as their management needs. As of 2018, Tracy's public tree inventory includes 35,561 trees along streets and in parks. Considering species composition, diversity, age distribution, condition, canopy coverage, and replacement value, DRG determined that the following information characterizes Tracy's public tree inventory:

- 191 unique tree species were identified in the inventory.
- The predominant species are flowering pear (*Pyrus calleryana*, 10.1%), Chinese pistache (*Pistacia chinensis*, 9.3%), and Raywood ash (*Fraxinus angustifolia*, 8.1%).
- 71.0% of trees are less than 12 inches in diameter (DBH)[1] , indicating a young, established resource that will provide greater benefits over time as individual trees mature. 5.3% of trees are larger than 24 inches in diameter.
- 82.5% of trees are deciduous broadleaf. Broadleaf evergreens are the second most prevalent at 10.0%.
- Public trees provide an estimated 424 acres of canopy cover, approximately 2.6% of total land area.
- Replacement of the 35,561 public trees with trees of equivalent size, species, and condition, would cost nearly $60.1 million.

---

[1] DBH: Diameter at Breast Height. DBH represents the diameter of the tree when measured at 1.4 meters (4.5 feet) above ground (U.S.A. standard).

Benefits

Annually, Tracy's public trees provide cumulative benefits to the community at an average value of $160.10 per tree, for a total value of nearly $5.7 million. These benefits include:

- Reducing electricity (4,365.2 MWh) and natural gas (18,564 Therms) use through shading and climate effects for a benefit of $947,243, an average of $26.64 per tree.
- Intercepting nearly 23.3 million gallons of stormwater, valued at $181,658, an average of $5.11 per tree.
- Reducing atmospheric carbon dioxide by 2,967 tons, valued at $44,502, an average of $1.25 per tree.
- Improving air quality by removing 31,172 pounds of pollutants, valued at $469,360, an average of $13.20 per tree.
- Increasing property values for aesthetic and socioeconomic benefits worth over $4 million, an average of $113.89 per tree.

When the annual investment of $1.4 million for the management of public trees is considered, the annual net benefit (benefits minus investment) to the community is $5.7 million. In other words, **for every $1 invested in public trees, the community receives $4.06 in benefits.**

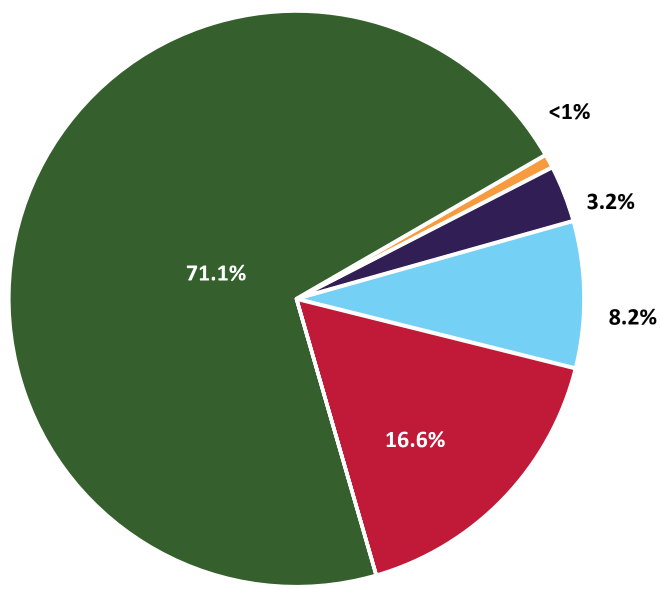

Figure 1: Benefits from the Public Tree Inventory in Tracy

Management

Tracy's public tree inventory is a dynamic resource that requires continued investment to maintain and realize its full benefit potential. Trees are one of the few community assets that have the potential to increase in value with time and proper management.

Appropriate and timely tree care can substantially increase lifespan. When trees live longer, they provide greater benefits. As individual trees mature, and aging trees are replaced, the overall value of the community forest and the amount of benefits provided grow as well. However, this vital living resource is vulnerable to a host of stressors and requires ecologically sound and sustainable best management practices to ensure a continued flow of benefits for future generations. With proactive management, planning, and new and replacement tree planting, the benefits from this resource will continue to increase as young trees mature.

Based on this resource analysis, DRG recommends the following:

- Provide structural pruning for young trees and a regular pruning cycle for all trees.
- Protect existing trees and manage risk with regular inspection to identify and mitigate structural and age-related defects and reduce the likelihood of tree and branch failure.
- Increase species diversity in new and replacement tree plantings to reduce reliance on the most prevalent species.
- Continue to maintain and update the inventory database, including tracking tree growth and condition during regular pruning cycles.
- Use available planting sites to improve diversity and increase benefits. Plant large-stature species for greater benefits wherever space allows.

With adequate protection and planning, the value of the public tree inventory in Tracy will continue to increase over time. Proactive management and a tree replacement plan are critical to ensuring that residents continue to receive a high return on their investment. Along with new tree installations and replacement plantings, funding for tree maintenance and inspection is vital to preserving benefits, prolonging tree life, and managing risk. Existing mature trees should be maintained and protected whenever possible since the greatest benefits accrue from the continued growth and longevity of the existing canopy. Managers can take pride in knowing that public trees support the quality of life for residents and neighboring communities.

Trees shading benches in playground.

Introduction

Tracy is in San Joaquin County, within an hour of San Jose, San Francisco, and Sacramento. Although Tracy is generally considered a bedroom community, the City is currently experiencing significant growth in the industrial and commercial employment sectors. Tracy is located inside a geographic triangle formed by Interstate 205, Interstate 5, and Interstate 580, which contributes to the City's motto of "Think inside the Triangle". In addition to the laid back and friendly character of Tracy, the city is close to numerous recreational opportunities, such as, Lake Tahoe, Yosemite, and San Francisco Bay.

Tracy has a semidesert climate with an average annual precipitation around 13.3 inches, which is less than other communities in the San Joaquin Valley. With the average low temperature in winter of 37°F and summers with an average high temperature of 93°F (U.S. Climate Data, 2018). The average annual wind speed for Tracy is 7.6 MPH, with a prevailing wind from the northwest (Weather Spark, 2018)

Individual trees and a healthy urban forest play an important role in the quality of life and the sustainability of every community. Research demonstrates that healthy trees can improve the local environment and diminish the impact resulting from urbanization and industry (Center for Urban Forest Research, 2017). Trees improve air quality by manufacturing oxygen and absorbing carbon dioxide (CO_2), as well as filtering and reducing airborne particulate matter such as smoke and dust. Urban trees reduce energy consumption by shading structures from solar energy and reducing the overall rise in temperature created through urban heat island effects (EPA). Trees slow and reduce stormwater runoff, helping to protect critical waterways from excess pollutants and particulates. In addition, urban trees provide critical habitat for wildlife and promote a connection to the natural world.

In addition to these direct improvements, healthy urban trees increase the overall attractiveness of a community and the value of local real estate by 7% to 10%, as well as, promoting shopping, retail sales, and tourism (Wolf, 2007). Trees support a more livable community, fostering psychological health, and providing residents with a greater sense of place (Ulrich, 1986; Kaplan, 1989). Trees soften the urban hardscape by providing a green sanctuary, making Tracy a more enjoyable place to live, work, and play.

The tree inventory data was analyzed with i-Tree's *Streets*, a STRATUM Analysis Tool (*Streets* v5.1.5; i-Tree v6.1.19), to develop a resource analysis and report of the existing condition of the public tree inventory. This report, unique to Tracy, quantifies the value of the public tree resource regarding actual benefits. In addition, the report provides baseline values that can be used to develop and update a public tree resource management plan. Management plans help communities determine where to focus available resources and set benchmarks for measuring progress.

This analysis describes the structure, function, and value of Tracy's public tree resource. With this information, managers and citizens can make informed decisions about tree management strategies. This report provides the following information:

- A description of the current structure of Tracy's public tree resource and an established benchmark for future management decisions.
- The economic value of the benefits from the public tree resource, illustrating the relevance and relationship of trees to local quality of life issues such as air quality, environmental health, economic development, and psychological health.
- Data that may be used by resource managers in the pursuit of alternative funding sources and collaborative relationships with utility purveyors, non-governmental organizations, air quality districts, federal and state agencies, legislative initiatives, or local assessment fees.
- Benchmark data for developing a long-term resource management plan.

Trees promote connection to the natural environment.

Public Tree Resource

A tree resource is more thoroughly understood through examination of composition and species richness of diversity (Figure 2). Consideration of stocking level, canopy cover, age distribution, condition, and performance provide a foundation for planning and management strategies. Inferences based on this data can help managers understand the importance of individual tree species to the overall forest as it exists today and provide a basis to project the future potential of the resource.

Population Composition

Broadleaf species dominate Tracy's public tree resource, representing 92.5% of the total inventory. Broadleaf trees typically have larger canopies than coniferous trees of the same size. Since many of the measurable benefits derived from trees are directly related to leaf surface area, broadleaf trees generally provide the greatest level of benefits to a community. Larger-statured broadleaf tree species provide greater benefits than smaller-statured trees, independent of diameter. Broadleaf deciduous species comprise 84% of Tracy's tree inventory, with 27.2% large-stature, 40.6% medium-stature, and 16.1% small-stature trees. Evergreen conifers comprise 7.5% of the population, with 6.0% large-stature and 1.5% medium-stature. Broadleaf evergreen trees comprise 10.0% of the population, with 1.5% large-stature, 4.3% medium-stature, and 4.2% small-stature trees. There are 2 (<1%) large palms and 5 (<1%) small palms, composing less than 1% of the population[2].

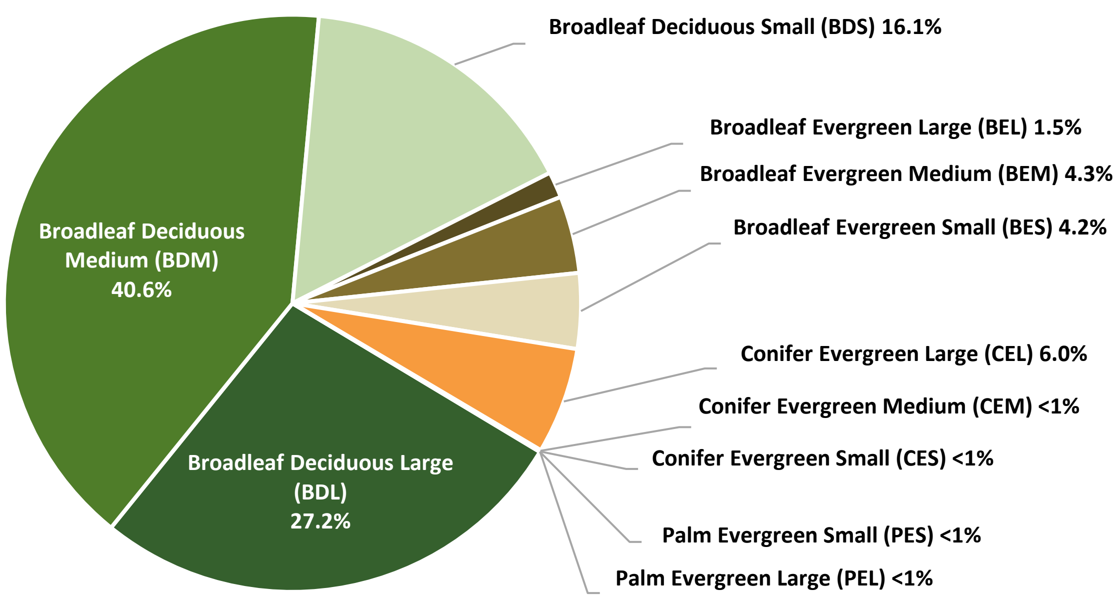

Figure 2: Composition of Public Tree Type in Tracy

[2] Palm size is defined by canopy spread rather than height. For instance, a Mexican fan palm (*Washingtonia robusta*), which can grow 100 feet or more, but has a canopy spread of approximately ten to twelve feet is considered a small palm.

Species Diversity

Tracy's public tree population includes a mix of 191 unique species (Table 1 and Appendix C), significantly more than that of the mean of 53 species reported by McPherson and Rowntree (1989) in their nationwide survey of street tree populations in 22 U. S. cities.

The top five most prevalent species represent more 41.6% of the overall population, including: flowering pear (*Pyrus calleryana*, 10.1%), Chinese pistache (*Pistacia chinensis*, 9.3%), Raywood ash (*Fraxinus angustifolia*, 8.1%), London planetree (*Platanus x acerifolia*, 7.8%, and crape myrtle (*Lagerstroemia indica*, 6.3%).

Crape myrtles represent 6.3% of the overall population.

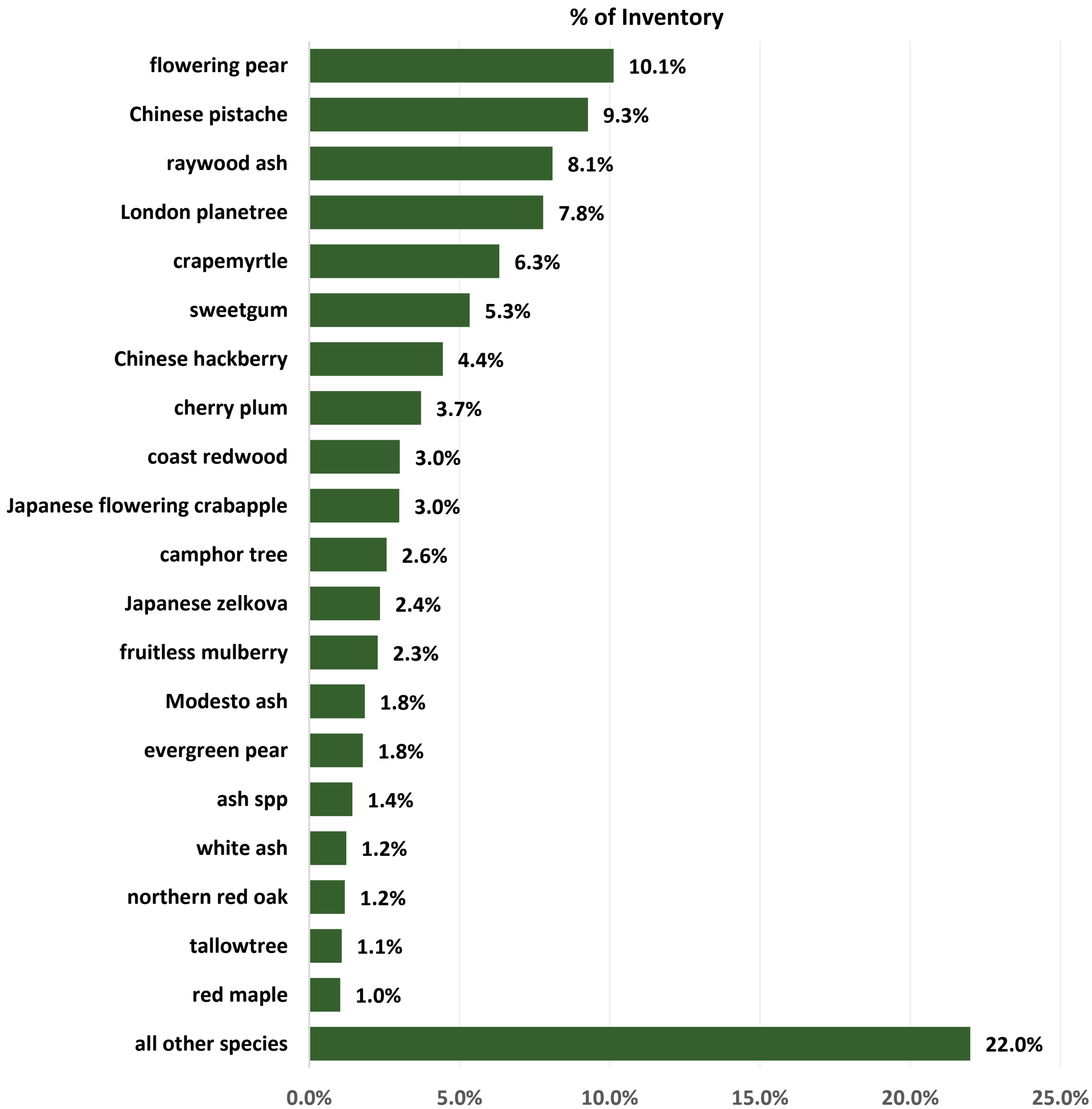

Figure 3: Most Prevalent Species in Tracy

Maintaining diversity in a public tree resource is important. Dominance of any single species or genus can have detrimental consequences in the event of storms, drought, disease, pests, or other stressors that can severely affect a public tree resource and the flow of benefits and costs over time. Catastrophic pathogens, such as Dutch elm disease (*Ophiostoma ulmi*), Emerald Ash Borer (*Agrilus planipennis*), Asian Longhorned Beetle (*Anoplophora glabripennis*), and Sudden Oak Death (*Phytophthora ramorum*) are some examples of unexpected, devastating, and costly pests and pathogens that highlight the importance of diversity and the balanced distribution of species and genera. In addition to these pests there is growing concern for Polyphagus Shot Hole Borer (PSHB) (*Euwallacea* sp.), a new pest that has devastated Southern California trees due to its wide host range, including avocado (*Persea americana)* and boxelder (*Acer negundo*) (Eskalen, 2015).

Recognizing that all tree species have a potential vulnerability to pests and disease, urban forest managers have long accepted a rule of thumb that no single species should represent greater than 10% of the total population and no single genus more than 20%, (Santamour, 1990). Among Tracy's public tree population, only flowering pear violates this well accepted rule and no genera exceed 20%. However, with increasing threats of pests and the unknowns of climate change, thoughts on diversity goals are evolving and urban forest managers are starting to set diversity percentages based on species palettes (an inclusive list of available proven/adapted species that are suitable as street trees in a geographical area, which includes species and their subspecies or varieties) and full stocking capacities (total available planting sites) (Simons and Hauer, 2015; Hauer, 2014). This approach allows urban forest managers to set thresholds based on the size of a community, as well as ensuring that the right trees are planted in the right place. An accurate assessment of all available planting sites and an up-to-date inventory are critical to this process.

Table 1: Population Summary of Tracy's Most Prevalent Species (representing >1%)

	DBH Class (in)							
Species	**0-6**	**6-12**	**12-18**	**18-24**	**24-30**	**> 30**	**Total**	**% of Pop.**
Broadleaf Deciduous Large (BDL)								
London planetree	266	1,109	870	360	133	30	2,770	7.8%
sweetgum	747	887	244	20	2	0	1,900	5.3%
Chinese hackberry	273	854	354	77	19	4	1,581	4.4%
Modesto ash	0	17	52	172	245	171	657	1.8%
white ash	334	100	1	2	1	0	438	1.2%
northern red oak	271	113	31	5	1	0	422	1.2%
all other BDL	615	777	230	145	99	42	1,908	5.4%
Total	**2,506**	**3,857**	**1,782**	**781**	**500**	**247**	**9,676**	**27.2%**
Broadleaf Deciduous Medium (BDM)								
flowering pear	607	1,824	913	221	36	1	3,602	10.1%
Chinese pistache	1,382	1,641	250	16	7	1	3,298	9.3%
Raywood ash	212	1,148	892	458	163	6	2,879	8.1%
Japanese zelkova	309	406	64	26	34	0	839	2.4%
fruitless mulberry	5	49	171	245	243	98	811	2.3%
ash spp	176	149	31	37	78	41	512	1.4%
tallowtree	27	221	118	16	2	0	384	1.1%
red maple	188	168	9	0	1	1	367	1.0%
all other BDM	536	594	297	189	127	17	1,761	5.0%
Total	**3,442**	**6,200**	**2,745**	**1,208**	**691**	**165**	**14,453**	**40.6%**
Broadleaf Deciduous Small (BDS)								
Crape myrtle	2,064	171	12	1	0	1	2,249	6.3%
flowering plum	531	749	41	2	0	0	1,323	3.7%
Japanese flowering crabapple	940	125	0	0	0	0	1,065	3.0%
all other BDS	824	219	18	4	2	0	1,067	3.0%
Total	**4,365**	**1,266**	**72**	**7**	**2**	**1**	**5,713**	**16.1%**

Broadleaf Evergreen Large (BEL)								
all other BEL	204	136	73	56	43	8	520	1.5%
Total	**204**	**136**	**73**	**56**	**43**	**8**	**520**	**1.5%**
Broadleaf Evergreen Medium (BEM)								
camphor tree	161	441	250	55	8	1	916	2.6%
all other BEM	266	139	76	72	51	17	621	1.7%
Total	**427**	**580**	**326**	**127**	**59**	**18**	**1,537**	**4.3%**
Broadleaf Evergreen Small (BES)								
evergreen pear	105	355	164	11	0	0	635	1.8%
all other BES	349	370	106	38	5	1	869	2.4%
Total	**454**	**725**	**270**	**49**	**5**	**1**	**1,504**	**4.2%**
Conifer Evergreen Large (CEL)								
coast redwood	96	453	407	102	14	1	1,073	3.0%
all other CEL	203	326	207	193	104	14	1,047	2.9%
Total	**299**	**779**	**614**	**295**	**118**	**15**	**2,120**	**6.0%**
Conifer Evergreen Medium (CEM)								
all other CEM	3	4	1	14	2	1	25	0.1%
Total	**3**	**4**	**1**	**14**	**2**	**1**	**25**	**0.1%**
Conifer Evergreen Small (CES)								
all other CES	0	0	5	1	0	0	6	0.0%
Total	**0**	**0**	**5**	**1**	**0**	**0**	**6**	**0.0%**
Palm Evergreen Large (PEL)								
all other PEL	0	1	0	1	0	0	2	0.0%
Total	**0**	**1**	**0**	**1**	**0**	**0**	**2**	**0.0%**
Palm Evergreen Small (PES)								
all other PES	0	5	0	0	0	0	5	0.0%
Total	**0**	**5**	**0**	**0**	**0**	**0**	**5**	**0.0%**
all trees	**11,700**	**13,553**	**5,888**	**2,539**	**1,420**	**456**	**35,561**	**100.0%**

Species Importance

To quantify the significance of any one species in Tracy's public tree resource, an importance value (IV)[3] is derived for each of the most prevalent species. Importance values are particularly meaningful to public tree resource managers because they indicate a reliance on the functional capacity of a species. **i-Tree *Streets* calculates importance value based on the mean of three values: percentage of total population, percentage of total leaf area, and percentage of total canopy cover.** Importance value goes beyond tree numbers alone to suggest reliance on specific species based on the benefits they provide. The importance value can range from zero (which implies no reliance) to 100 (suggesting total reliance). A complete table, with importance values for all species, is included in Appendix C.

Because importance value goes beyond population numbers alone, it can help managers to better comprehend the resulting loss of benefits from a catastrophic loss of any one species. When importance values are comparatively equal among the 10 to 15 most prevalent species, the risk of significant reductions to benefits is reduced. Of course, suitability of the dominant species is another important consideration. Planting short-lived or poorly adapted species can result in short rotations and increased long-term management costs.

The 20 most prevalent (representing greater than 1%) species in Tracy's public tree inventory represent 78.0% of the overall population, 76.6% of the total leaf area, and 78.6% of the total canopy cover for a combined importance value of 77.7. Of these, Tracy relies most on London planetree (*Platanus x acerfolia*, IV=10.9), flowering pear (*Pyrus calleryana*, IV=10.2), Raywood ash (*Fraxinus oxycarpa* 'Raywood', IV=10.3), and Chinese pistache (*Pistachia chinensis*, IV=8.1). Combined, these species represent 35.3% of the inventory, providing significant benefits and a sense of place. They are key to sustaining the benefits provided by the public tree resource, as well as preserving the essence of Tracy for years to come.

Some species are more significant contributors to the urban forest than population numbers would suggest. For example, Modesto ash (*Fraxinus velutina 'Modesto'*, IV=4.3) represents just 1.8% of the population, but 5.3% of canopy cover and 5.8% of leaf surface area. This large-stature species is represented by a significant portion (97.4%) of established trees (>12" DBH).

For some species, low importance values are primarily a function of tree type. Immature or small-stature species frequently have lower importance values than their

---

[3] Importance values reflect the contribution that a particular species is making towards the overall benefits. The importance value does not indicate that a species is well suited or desirable for local conditions.

representation in the inventory might suggest. This is largely due to relatively small leaf area and canopy coverage. For example, crape myrtle (*Lagerstroemia indica)* represents 6.3% of the population, but the importance value is 2.75. This small-stature species only contributes to 0.9% of the total leaf area and 1.1% of the canopy and the benefits are unlikely to increase much over time. Conversely, red maple (*Acer rubrum*) currently has an importance value of 0.8. However, 97% of this population is smaller than 12 inches in diameter and as this medium-stature species matures over time, it's importance value will also increase.

Table 2: Importance Value of Tracy's Prevalent Species

Species	Number of Trees	% of Total Trees	Leaf Area (ft²)	% of Total Leaf Area	Canopy Cover (ft²)	% of Total Canopy Cover	Importance Value
flowering pear	3,602	10.1	5,486,665	9.6	1,997,191	10.8	**10.2**
Chinese pistache	3,297	9.3	3,546,667	6.2	1,613,906	8.7	**8.1**
Raywood ash	2,879	8.1	7,050,536	12.4	1,932,908	10.5	**10.3**
London planetree	2,768	7.8	6,674,961	11.7	2,438,082	13.2	**10.9**
crape myrtle	2,249	6.3	489,238	0.9	198,895	1.1	**2.8**
sweetgum	1,900	5.3	2,282,276	4.0	464,881	2.5	**4.0**
Chinese hackberry	1,581	4.4	3,291,915	5.8	989,129	5.4	**5.2**
flowering plum	1,323	3.7	760,132	1.3	244,962	1.3	**2.1**
coast redwood	1,073	3.0	2,141,387	3.8	471,444	2.6	**3.1**
Japanese flowering crabapple	1,065	3.0	257,529	0.5	101,189	0.5	**1.3**
camphor tree	916	2.6	1,143,199	2.0	443,944	2.4	**2.3**
Japanese zelkova	839	2.4	1,345,257	2.4	519,657	2.8	**2.5**
fruitless mulberry	811	2.3	2,751,018	4.8	946,063	5.1	**4.1**
Modesto ash	657	1.8	3,288,660	5.8	981,570	5.3	**4.3**
evergreen pear	635	1.8	828,826	1.5	320,167	1.7	**1.7**
ash spp	512	1.4	917,490	1.6	313,442	1.7	**1.6**
white ash	438	1.2	283,675	0.5	90,224	0.5	**0.7**
northern red oak	421	1.2	222,921	0.4	81,484	0.4	**0.7**
tallowtree	384	1.1	614,305	1.1	227,135	1.2	**1.1**
red maple	367	1.0	334,901	0.6	134,852	0.7	**0.8**
all other species	7,839	22.0	13,323,296	23.4	3,961,211	21.4	**22.3**
All Species	**35,556**	**100%**	**57,034,856**	**100%**	**18,472,334**	**100%**	**1.0**

Leaf Surface Area

The amount and distribution of leaf surface area is the driving force behind the public tree resource's ability to produce benefits for the community (Clark et al., 1997). As canopy cover increases, so do the benefits afforded by leaf area. The City of Tracy covers an area of 22.3 square miles. i-Tree estimates that public trees are providing nearly .7 square miles (424 acres) of canopy cover which accounts for 3.0% of total land area.

Relative Age Distribution

Age distribution can be approximated by considering the DBH range of the overall inventory and of individual species. Trees with smaller diameters tend to be younger. It is important to note that palms do not increase in DBH over time, so they are not considered in this analysis. In palms, height more accurately correlates to age.

The distribution of individual tree ages within a tree population influences present and future costs as well as the flow of benefits. An ideally-aged population allows managers to allocate annual maintenance costs uniformly over many years and assures continuity in overall tree canopy coverage and associated benefits. A desirable distribution has a high proportion of young trees to offset establishment and age-related mortality as the percentage of older trees declines over time (Richards, 1982/83). This ideal, albeit uneven, distribution suggests a large fraction of trees (~40%) should be young, with a diameter less than eight (8) inches, while only 10% should be in the large diameter classes (>24 inches DBH).

The age distribution of Tracy's public tree resource (excluding palms) represents a young, but established population. Trees 6 inches or less DBH represent 33% of the overall population, tree 6 to 12 inches DBH represent 38%. and 5.3% of trees are larger than 24 inches DBH (Figure 4).

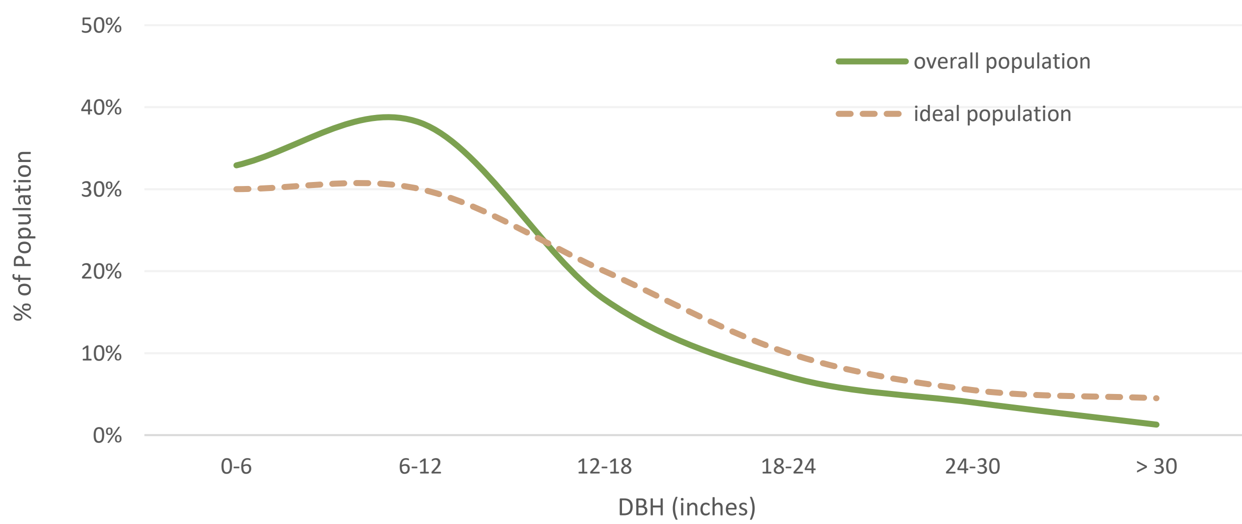

Figure 4: Community Tree Resource Age Distribution for Tracy

Relative age distribution can also be evaluated for each individual species. Figure 5 illustrates the age distribution of the top 10 most prevalent species compared against the ideal distribution.

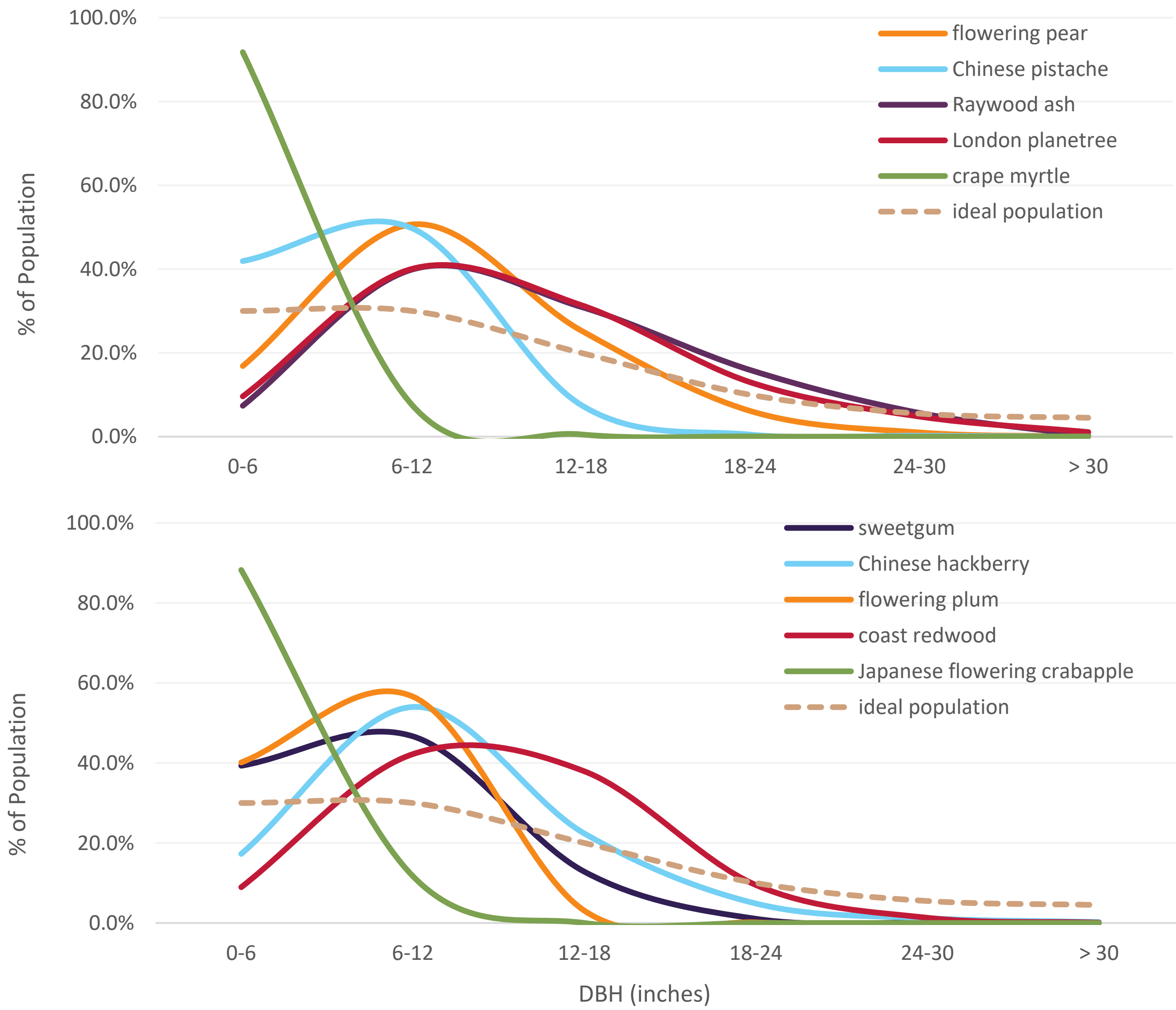

Figure 5: Relative Age Distribution of Top 10 Most Prevalent Species (Excluding Palms)

The age distribution of prevalent species can help resource managers to understand and foresee maintenance activities and budgetary needs. In addition to informing managers of the economics of prevalent species, age distribution can be used to identify trends in plantings and adopt strategies for species selection in the years to come.

Of Tracy's top 10 most prevalent public tree species (Figure 5), crape myrtle (*Lagerstroemia indica*) and Japanese flowering crabapple (*Malus floribunda*) are two small statured tree species that in recent years have been planted more frequently than in years prior. In addition, Tracy's most important species London planetree (*Platanus x acerfolia*, IV=10.9) and Raywood ash (*Fraxinus oxycarpa* 'Raywood', IV=10.3) have been planted less frequently than in years prior, but both have well established populations. With regular inspection and management, the benefits provided by trees have a high potential to increase as trees grow and become established.

Tree Condition and Relative Performance

Tree condition is an indication of how well trees are managed and how well they are performing in each site-specific environment (e.g., street, median, parking lot, etc.). Condition ratings can help managers anticipate maintenance and funding needs. In addition, tree condition is an important factor for the calculation of public tree resource benefits. A condition rating of good assumes that a tree has no major structural problems, no significant mechanical damage, and may have only minor aesthetic, insect, disease, or structural problems, and is in good health. When trees are performing at their peak, as those rated as good or better, the benefits they provide are maximized.

Tracy's public tree inventory does not include current information about the condition of each tree. For the purposes of this analysis, a default condition rating of fair was applied to all trees in the inventory. A condition rating of fair assumes that a tree has minor structural problems, minor mechanical damage, and minor aesthetic, insect, disease, or structural problems, and is in fair health. While the condition rating is likely quite variable between individual street trees, this default rating was determined to be representative of the overall population.

Relative Performance Index

The *relative performance index* (RPI) is one way to further analyze the condition and suitability of a specific tree species. The RPI provides an urban forest manager with a detailed perspective on how different species perform compared to each other. The index compares the condition ratings of each tree species with the condition ratings of every other tree species within the inventory. RPI was not part of this analysis because Tracy's current street tree inventory data does not include condition ratings. Collecting and updating tree condition ratings can help resource managers and planners identify the best species for optimizing benefits and controlling costs.

Replacement Value

The current replacement value of Tracy's public tree resource is more than $60.1 million (Table 3). The replacement value accounts for the historical investment in trees over their lifetime. The replacement value is also a way of describing the value of a tree population (and/or average value per tree) at a given time. The replacement value reflects current population numbers, stature, and condition. There are several methods available for obtaining a fair and reasonable perception of a tree's value (CTLA, 1992; Watson, 2002). The trunk formula method used by i-Tree *Streets* assumes the value of a tree is equal to the cost of replacing the tree in its current state (Cullen, 2002).

Nearly 35% of the overall replacement value is attributable to Raywood ash (*Fraxinus oxycarpa* 'Raywood'), flowering pear (*Pyrus calleryana*), and London planetree (*Platanus acerfolia*) for a total of nearly $21 million. These species represent 26% of the total tree population. Raywood ash has the highest replacement value of more than $8.2 million or nearly $2,853 per tree. The average per tree replacement value for all trees in the inventory is $1,692.

The replacement value for Tracy's public tree resource reflects the vital importance of these assets to the community. With proper care and maintenance, the value will continue to increase over time. It is important to recognize that replacement values are separate and distinct from the value of annual benefits produced by this public tree resource and in some instances the replacement value of a tree may be greater than, or less than, the benefits that that tree may provide.

People enjoying shaded walking path.

Table 3: Replacement Value for Tracy's Most Prevalent Species

Species	DBH Class (in)								
	0-6	6-12	12-18	18-24	24-30	> 30	Total	% of Total Replacement Value	% of Population
flowering pear	135,490	2,075,856	2,709,613	1,262,443	337,388	11,360	6,532,150	10.9	10.1
Chinese pistache	394,847	3,171,179	1,306,497	162,660	117,273	20,331	5,172,788	8.6	9.3
Raywood ash	47,321	1,306,515	2,647,289	2,616,285	1,527,617	68,157	8,213,184	13.7	8.1
London planetree	50,215	1,047,523	2,136,840	1,700,459	1,030,304	281,661	6,247,002	10.4	7.8
crape myrtle	549,679	280,992	52,764	8,528	0	17,027	908,989	1.5	6.3
sweetgum	166,739	1,009,476	724,146	114,248	18,744	0	2,033,354	3.4	5.3
Chinese hackberry	51,537	806,659	869,473	363,709	147,186	37,555	2,276,118	3.8	4.4
flowering plum	101,933	554,923	75,388	6,971	0	0	739,214	1.2	3.7
coast redwood	16,308	350,792	807,230	387,279	87,008	7,528	1,656,146	2.8	3.0
Japanese flowering crabapple	250,338	205,403	0	0	0	0	455,741	0.8	3.0
camphor tree	40,968	677,055	1,024,225	436,664	104,501	15,845	2,299,259	3.8	2.6
Japanese zelkova	78,628	623,321	262,202	206,423	444,128	0	1,614,702	2.7	2.4
fruitless mulberry	960	36,303	314,422	853,944	1,380,523	673,631	3,259,784	5.4	2.3
Modesto ash	0	7,051	48,512	294,143	672,871	565,888	1,588,466	2.6	1.8
evergreen pear	24,327	431,392	521,881	67,460	0	0	1,045,059	1.7	1.8
ash spp	33,786	110,392	57,000	128,963	443,131	281,825	1,055,097	1.8	1.4
white ash	84,989	153,527	4,097	15,879	13,063	0	271,555	0.5	1.2
tallowtree	6,870	339,295	483,434	127,029	26,125	0	982,755	1.6	1.1
red maple	30,606	99,889	13,123	0	4,481	5,419	153,518	0.3	1.0
northern red oak	68,959	173,486	127,004	39,697	13,063	0	422,208	0.7	1.2
all other species	698,148	2,844,650	2,623,795	3,043,388	3,045,179	981,604	13,236,763	22.0	22.0
All Species	**2,832,647**	**16,305,678**	**16,808,937**	**11,836,173**	**9,412,584**	**2,967,832**	**60,163,851**	**100%**	**100%**

To replace Tracy's public tree resource, it would cost nearly $60.1 million.

Benefits of Tracy's Public Trees

Public trees are important to Tracy. They help lessen energy use, reduce carbon dioxide (CO_2) levels, improve air quality, and mitigate stormwater runoff. Additionally, trees provide a wealth of well-documented psychological, social, and economic benefits related primarily to their aesthetic effects. Environmentally, trees make good sense, providing quantifiable benefits to the community; however, the question remains, are the collective benefits worth the cost of management? In other words, are these trees a worthwhile investment for the community? To answer this question, the benefits must be quantified in financial terms.

The i-Tree *Streets* analysis model quantifies benefits based on regional reference cities and local attributes, such as median home values and local energy prices. This analysis provides a snapshot of the annual benefits (along with the value of those benefits) produced by Tracy's tree population. While the annual benefits produced by these trees can be substantial, it is important to recognize that the greatest benefits are derived from the benefit stream that results over time, from a mature population where trees are well managed, healthy, and long-lived.

This analysis used Tracy's current inventory data with i-Tree's *Streets* software to assess and quantify the beneficial functions of this resource and to place a dollar value on the annual environmental benefits these trees provide[4]. The benefits calculated by i-Tree *Streets* are estimations based on the best available and current scientific research with an accepted degree of uncertainty. The data returned from i-Tree *Streets* can provide a platform from which informed management decisions can be made (Maco and McPherson, 2003). A discussion on the methods used to calculate and assign a monetary value to these benefits is included in Appendix C.

[4] The level of benefits provided by a particular species are heavily influenced by stature and leaf surface contribution. Some tree species that provide high benefits may not be desirable or well-suited to the local environment.

Atmospheric Carbon Dioxide Reduction

As environmental awareness continues to increase, governments are paying attention to global warming and the effects of greenhouse gas (GHG) emissions. As energy from the sun (sunlight) strikes the Earth's surface it is reflected into space as infrared radiation (heat). GHGs absorb some of this infrared radiation and trap heat in the atmosphere, modifying the temperature of the Earth's surface. Many chemical compounds in the Earth's atmosphere act as GHGs, including carbon dioxide (CO_2), water vapor, and human-made (gases/aerosols). As GHGs increase, the amount of energy radiated back into space is reduced, and more heat is trapped in the atmosphere. An increase in the average temperature of the Earth may result in changes in weather, sea levels, and land-use patterns, commonly referred to as "climate change."

The Center for Public Urban Forest Research (CUFR) recently led the development of Public Urban Forest Project Reporting Protocol. The protocol, which incorporates methods of the Kyoto Protocol and Voluntary Carbon Standard (VCS), establishes methods for calculating reductions, provides guidance for accounting and reporting, and guides public tree resource managers in developing tree planting and stewardship projects that could be registered for GHG reduction credits (offsets). The protocol can be applied to urban tree planting projects within municipalities, campuses, and utility service areas anywhere in the United States.

While the public tree resource in Tracy may or may not qualify for carbon-offset credits or be traded in the open market, the City's trees are nonetheless providing a significant reduction in atmospheric carbon dioxide (CO_2) for a positive environmental and financial benefit to the community.

Urban trees reduce atmospheric CO_2 in two ways:

- Directly, through growth and the sequestration of CO_2 in wood, foliar biomass, and soil.
- Indirectly, by lowering the demand for heating and air conditioning, thereby reducing the emissions associated with electric power generation and natural gas consumption. This is also referred to as avoided CO_2

Conversely, CO_2 is released by vehicles and other combustible engines used to plant and care for trees. Additionally, when a tree dies, most of the CO_2 that accumulated as woody biomass is released back into the atmosphere during decomposition, except in cases where the wood is recycled. Each of these factors must be considered when calculating the CO_2 reduction benefits of trees.

Sequestered Carbon Dioxide

As of 2018, Tracy's public trees have stored more than 20,032 tons of carbon (CO_2) in woody and foliar biomass valued at $300,490.

Annually, all Tracy public trees combined sequester an additional 1,078 tons of CO_2, valued at $16,171. Accounting for estimated CO_2 emissions from tree decomposition (-229 tons), tree related maintenance activity (-23 tons), and avoided CO_2 (1,580 tons), Tracy's public trees provide an annual net reduction in atmospheric CO_2 of 2,406 tons, valued at $36,095, with an average value of $1.02 per tree (Table 4).

Among prevalent species, Modesto ash (*Fraxinus velutina 'Modesto')* provide the greatest annual per-tree benefits ($1.88) to carbon sequestration (Figure 6). Raywood ash (*Fraxinus oxycarpa*) provides the greatest carbon benefits by population, valued at $4,384, accounting for 12.1% of the total benefit.

To date, Tracy's public trees have stored more than 20,032 tons of carbon (CO_2) in woody and foliar biomass.

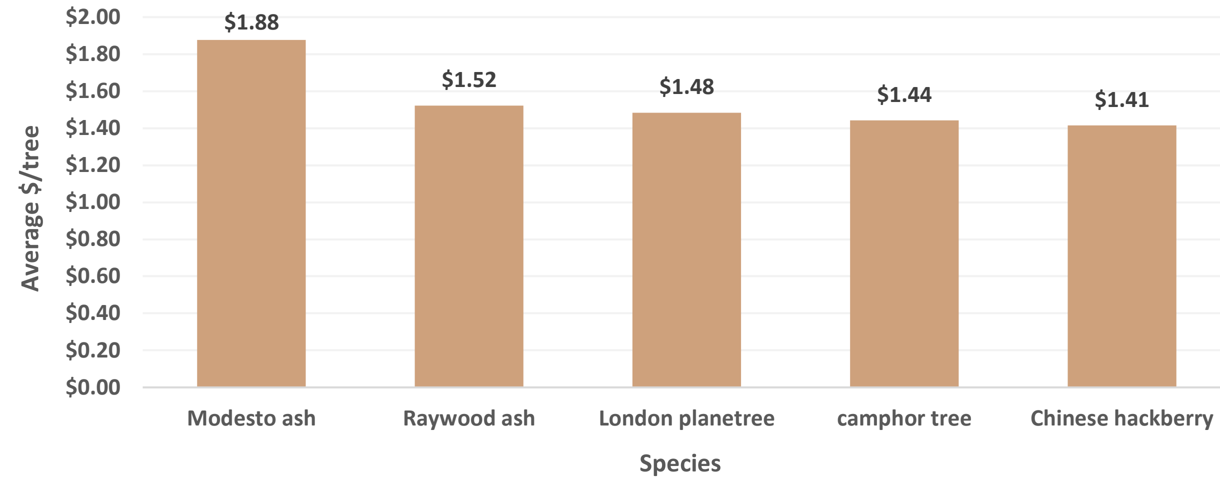

Figure 6: Top Five Species for Carbon Benefit

Table 4: Annual Carbon Benefits from Tracy's Most Prevalent Species

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release (lb)	Maintenance Release (lb)	Total Release ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
flowering pear	160,590	1,204	-38,534	-4,885	-325.64	348,605	2,614.54	465,777	3,493.33	10.13	9.68	**0.97**
Chinese pistache	104,297	782	-13,434	-3,019	-123.40	285,219	2,139.14	373,062	2,797.97	9.27	7.75	**0.85**
Raywood ash	298,683	2,240	-59,063	-5,023	-480.64	349,879	2,624.09	584,475	4,383.57	8.10	12.14	**1.52**
London planetree	219,474	1,646	-60,927	-4,676	-492.02	393,681	2,952.61	547,552	4,106.64	7.78	11.38	**1.48**
crape myrtle	7,563	57	-1,372	-1,032	-18.03	27,449	205.87	32,608	244.56	6.33	0.68	**0.11**
sweetgum	108,874	817	-10,220	-1,867	-90.65	104,330	782.48	201,117	1,508.38	5.34	4.18	**0.79**
Chinese hackberry	155,337	1,165	-17,559	-2,093	-147.39	162,536	1,219.02	298,221	2,236.65	4.45	6.20	**1.41**
flowering plum	5,820	44	-2,990	-1,167	-31.18	36,168	271.26	37,831	283.73	3.72	0.79	**0.21**
coast redwood	106,959	802	-10,700	-1,695	-92.96	95,171	713.78	189,735	1,423.01	3.02	3.94	**1.33**
Japanese flowering crabapple	3,703	28	-769	-513	-9.61	14,094	105.71	16,516	123.87	3.00	0.34	**0.12**
camphor tree	108,786	816	-13,892	-1,250	-113.57	82,471	618.54	176,115	1,320.86	2.58	3.66	**1.44**
Japanese zelkova	55,247	414	-7,599	-911	-63.82	87,272	654.54	134,010	1,005.07	2.36	2.78	**1.20**
fruitless mulberry	22,938	172	-30,090	-2,335	-243.19	155,094	1,163.21	145,607	1,092.05	2.28	3.03	**1.35**
Modesto ash	61,628	462	-47,595	-2,318	-374.34	152,635	1,144.76	164,350	1,232.63	1.85	3.41	**1.88**
evergreen pear	36,460	273	-4,110	-806	-36.87	53,876	404.07	85,420	640.65	1.79	1.77	**1.01**
ash spp	13,898	104	-8,445	-854	-69.74	52,384	392.88	56,983	427.37	1.44	1.18	**0.83**
white ash	19,750	148	-606	-258	-6.48	12,964	97.23	31,849	238.87	1.23	0.66	**0.55**
northern red oak	39,858	299	-3,144	-316	-25.95	14,052	105.39	50,451	378.38	1.18	1.05	**0.90**
tallowtree	18,534	139	-4,203	-550	-35.65	39,872	299.04	53,653	402.40	1.08	1.11	**1.05**
red maple	25,429	191	-1,485	-297	-13.37	26,685	200.14	50,333	377.49	1.03	1.05	**1.03**
all other species	582,290	4,367	-120,415	-10,116	-978.98	665,254	4,989.40	1,117,014	8,377.60	22.02	23.21	**1.03**
All Species	**2,156,119**	**$16,171**	**-457,152**	**-45,980**	**-$3,773.49**	**3,159,689**	**$23,697.67**	**4,812,677**	**$36,095.08**	**100%**	**100%**	**$1.02**

Air Quality Impacts

Urban trees improve air quality in five (5) fundamental ways:

- Absorption of gaseous pollutants such as ozone (O_3), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) through leaf surfaces
- Interception of particulate matter (PM_{10}), such as dust, ash, dirt, pollen, and smoke
- Increase of oxygen levels through photosynthesis
- Transpiration of water and shade provision, resulting in lower local air temperatures, thereby reducing ozone (O_3) levels

PM_{10} is particulate matter in the air that measures less than ten (10) micrometers, smaller than the width of a single human hair. These small particles or liquid droplets include smoke, soot, dust, and secondary reactions from gaseous pollutants. PM_{10} pollution is detrimental to health.

Ozone (O_3) is another air pollutant that is harmful to human health. Ozone forms when nitrogen oxide from fuel combustion and volatile organic gases from evaporated petroleum products react in the presence of sunshine. In the absence of cooling effects provided by trees, higher temperatures contribute to ozone (O_3) formation. Additionally, short-term increases in ozone concentrations are statistically associated with increased tree mortality for 95 large US cities (Bell et al., 2004). However, it should be noted that while trees do a great deal to absorb air pollutants (especially ozone and particulate matter); they also negatively contribute to air pollution. Trees emit biogenic volatile organic compounds (BVOCs), which also contribute to ozone formation. i-Tree *Streets* analysis accounts for these BVOC emissions in the air quality cumulative benefit.

Deposition, Interception, and Avoided Pollutants

Each year, 30,637 pounds of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), small particulate matter (PM_{10}), and ozone (O_3) are intercepted or absorbed by Tracy public trees, for a value of $359,884 (Table 5). As a population, London planetree (*Platanus x acerifolia*) is the greatest contributor to pollutant deposition and interception, accounting for 13.0% of these benefits.

Energy savings provided by trees have the additional indirect benefit of reducing air pollutant emissions (NO_2, PM_{10}, SO_2, and VOCs) that result from energy production. Altogether 25,598 pounds of pollutants, valued at $62,311, are avoided annually through the shading effects of trees.

More than over 5.7 tons of BVOCs are emitted annually from Tracy's public trees, reducing annual benefits to air quality by -$53,628. Of prevalent species, the heaviest emitters by population are London planetree and sweetgum (*Liquidambar styraciflua*) which together emit 60.4% of all BVOCs.

Figure 7: Top Five Species for Air Quality Benefits

The cumulative value of air pollutants removed by public trees in Tracy is $368,567 an average of $10.37 per tree. Flowering pear (*Pyrus calleryana*) are the greatest contributors to air quality benefits, accounting for 12.7% of these benefits (Table 5).

White mulberry trees provide an average $27.19 in air quality benefits per tree.

Table 5: Annual Air Quality Benefits from Tracy's Most Prevalent Species

Species	Deposition O_3 (lb)	Deposition NO_2 (lb)	Deposition PM_{10} (lb)	Deposition SO_2 (lb)	Total Deposition ($)	Avoided NO_2 (lb)	Avoided PM_{10} (lb)	Avoided VOC (lb)	Avoided SO_2 (lb)	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	% of Total Tree Numbers	Avg. $/tree
flowering pear	1,846	474	1,079	0	$39,831	437	81	22	190	7,153	0	0	4,128	46,984	10.1	13.04
Chinese pistache	1,479	356	740	0	$30,428	320	63	16	155	5,342	-1,255	-5,884	1,874	29,886	9.3	9.06
Raywood ash	1,706	407	838	0	$34,917	440	81	22	191	7,199	0	0	3,685	42,116	8.1	14.63
London planetree	2,171	554	1,257	0	$46,691	480	90	24	213	7,883	-3,505	-16,437	1,284	38,137	7.8	13.78
crape myrtle	165	39	80	0	$3,367	32	6	2	15	531	0	0	339	3,897	6.3	1.73
sweetgum	410	98	202	0	$8,398	113	23	6	57	1,905	-3,401	-15,953	-2,492	-5,650	5.3	-2.97
Chinese hackberry	906	218	453	0	$18,649	188	36	9	88	3,121	0	0	1,900	21,770	4.4	13.77
flowering plum	204	48	98	0	$4,147	42	8	2	19	693	0	0	422	4,839	3.7	3.66
coast redwood	479	137	341	0	$11,077	108	21	5	52	1,796	-289	-1,355	854	11,518	3.0	10.73
Japanese flowering crabapple	84	20	41	0	$1,713	16	3	1	8	272	0	0	173	1,985	3.0	1.86
camphor tree	451	129	321	0	$10,431	92	18	5	45	1,541	0	0	1,060	11,971	2.6	13.07
Japanese zelkova	459	110	225	0	$9,387	98	19	5	47	1,627	0	0	962	11,015	2.4	13.13
fruitless mulberry	875	224	511	0	$18,868	194	36	10	84	3,179	0	0	1,934	22,047	2.3	27.19
Modesto ash	846	191	374	0	$16,778	189	35	9	82	3,102	0	0	1,727	19,880	1.8	30.26
evergreen pear	325	93	231	0	$7,522	65	12	3	29	1,070	0	0	759	8,593	1.8	13.53
ash spp	290	74	169	0	$6,251	66	12	3	28	1,073	0	0	643	7,324	1.4	14.31
white ash	78	18	34	0	$1,542	16	3	1	7	265	0	0	157	1,808	1.2	4.13
northern red oak	83	24	59	0	$1,915	16	3	1	8	259	-256	-1,200	-64	974	1.2	2.31
tallowtree	210	54	123	0	$4,530	50	9	2	22	818	0	0	470	5,348	1.1	13.93
red maple	119	28	58	0	$2,436	29	6	1	15	494	-29	-136	228	2,794	1.0	7.61
all other species	3,731	970	2,219	0	$81,007	786	150	39	361	12,987	-2,700	-12,664	5,555	81,330	22.0	10.71
All Species	**16,917**	**4,264**	**9,455**	**0**	**$359,884**	**3,776**	**718**	**187**	**1,716**	**$62,311**	**-11,435**	**-$53,628**	**25,598**	**$368,567**	**100%**	**$10.37**

Stormwater Runoff Reductions

Rainfall interception by trees reduces the amount of stormwater that enters collection and treatment facilities during large storm events. Trees intercept rainfall in their canopy, acting as mini-reservoirs, controlling runoff at the source. Healthy urban trees reduce the amount of runoff and pollutant loading in receiving waters in three primary ways:

- Leaves and branch surfaces intercept and store rainfall, thereby reducing runoff volumes and delaying the onset of peak flows.
- Root growth and decomposition increase the capacity and rate of soil infiltration by rainfall and reduce overland flow.
- Tree canopies reduce soil erosion and surface flows by diminishing the impact of raindrops on bare soil.

Public trees in Tracy intercept nearly 18 million gallons of stormwater annually for an average of 505.2 gallons per tree (Table 6). The total value of this benefit to Tracy is $140,123, an average of $3.94 per tree.

Among the most prevalent species, Modesto ash (*Fraxinus velutina* 'Modesto') provides the greatest per tree benefit of $8.84 (Figure 8). London planetree (*Platanus x acerfolia*) provides the largest portion of stormwater benefit at 12.6%, which may be attributed to the species being the fourth most common tree in Tracy's public tree inventory, or 7.8% of the total population. Combined with the age distribution and stature of these trees, this explains the larger benefit that they provide by comparison to other species.

As trees grow, the benefits that they provide tend to grow as well. Admittedly, some species incur more benefits than others will, and a component of that reality is biology. Some trees have characteristics that hinder their ability to be strong contributors to stormwater runoff reduction, possibly due to a tree having smaller leaves and thinner canopies.

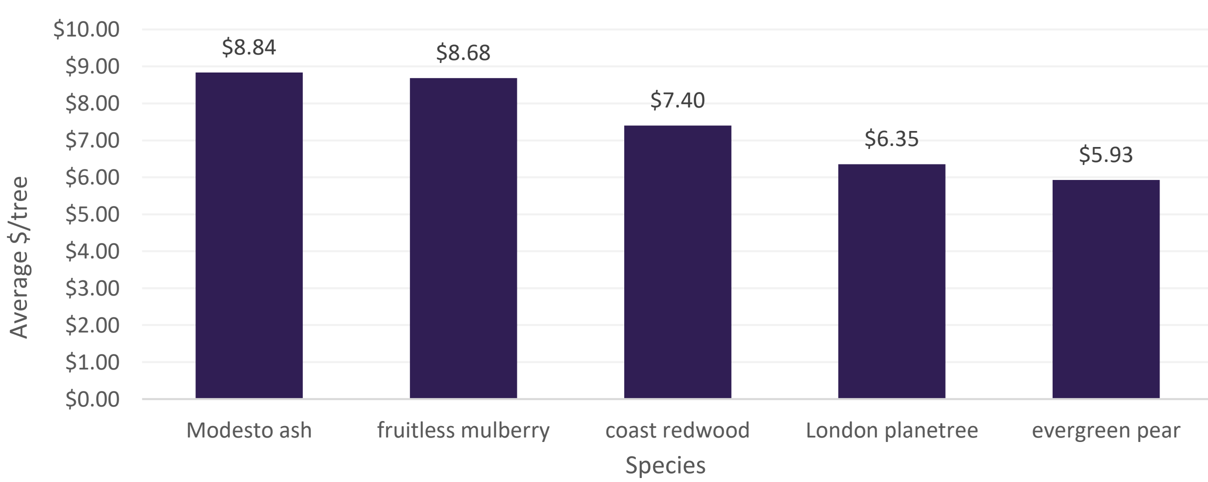

Figure 8: Top Five Species for Stormwater Benefits

Table 6: Annual Stormwater Benefits from Tracy's Most Prevalent Species

Species	Total Rainfall Interception (Gal)	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
flowering pear	1,854,190	14,463	10.13	10.32	4.02
Chinese pistache	1,096,542	8,553	9.27	6.10	2.59
Raywood ash	1,500,948	11,707	8.10	8.36	4.07
London planetree	2,253,933	17,581	7.78	12.55	6.35
crape myrtle	137,073	1,069	6.33	0.76	0.48
sweetgum	381,010	2,972	5.34	2.12	1.56
Chinese hackberry	771,788	6,020	4.45	4.30	3.81
flowering plum	179,724	1,402	3.72	1.00	1.06
coast redwood	1,017,727	7,938	3.02	5.67	7.40
Japanese flowering crabapple	70,334	549	3.00	0.39	0.52
camphor tree	655,616	5,114	2.58	3.65	5.58
Japanese zelkova	354,715	2,767	2.36	1.97	3.30
fruitless mulberry	902,640	7,041	2.28	5.02	8.68
Modesto ash	744,291	5,805	1.85	4.14	8.84
evergreen pear	482,378	3,763	1.79	2.69	5.93
ash spp	298,853	2,331	1.44	1.66	4.55
white ash	66,088	515	1.23	0.37	1.18
northern red oak	123,909	966	1.18	0.69	2.30
tallowtree	209,698	1,636	1.08	1.17	4.26
red maple	93,910	732	1.03	0.52	2.00
all other species	4,769,172	37,200	22.03	26.55	5.19
All Species	**17,964,540**	**$140,123**	**100%**	**100%**	**$3.94**

Energy Savings

Trees modify climate and conserve energy in three principal ways:

- Shading reduces the amount of radiant energy absorbed and stored by hardscape surfaces, thereby reducing the heat island effect.
- Transpiration converts moisture to water vapor, thereby cooling the air by using solar energy that would otherwise result in heating of the air.
- Reduction of wind speed plus the movement of outside air into interior spaces, and conductive heat loss where thermal conductivity is relatively high (e.g., glass windows) (Simpson, 1998).

The *heat island effect* describes the increase in urban temperatures in relation to surrounding suburban and rural areas. Heat islands are associated with an increase in hardscape and impervious surfaces. Trees and other vegetation within an urbanized environment help reduce the heat island effect by lowering air temperatures 5°F (3°C) compared with outside the green space (Chandler, 1965). On a larger scale, temperature differences of more than 9°F (5°C) have been observed between city centers without adequate canopy coverage and more vegetated suburban areas (Akbari et al., 1992). The relative importance of these effects depends upon the size and configuration of trees and other landscape elements (McPherson, 1993). Tree spacing, crown spread, and vertical distribution of leaf area each influence the transport of warm air and pollutants along streets and out of urban canyons. Trees reduce conductive heat loss from buildings by reducing air movement into buildings and against conductive surfaces (e.g., glass, metal siding). Trees can reduce wind speed and the resulting air infiltration by up to 50%, translating into potential annual heating savings of 25% (Heisler, 1986).

Electricity and Natural Gas Reduction

Electricity and natural gas saved annually in Tracy from both the shading and climate effects of public trees is equal to 3,362.7 MWh (valued at $711,543.24) and 12,443.5 Therms ($15,803.26), for a total retail savings of approximately $727,346.50 and an average of $20.46 per tree (Table 7). The species that contribute most to energy benefits on a per-tree basis are Modesto ash (*Fraxinus velutina* 'Modesto'), with an average value of $55.00 and fruitless mulberry (*Morus alba*) with an average value of $45.52 per tree (Figure 9).

On a per-tree basis, crape myrtle (*Lagerstroemia indica*) provides $2.82 in average energy benefits, just 0.9% of the total energy benefits. This is the least amount of energy benefits provided per tree, among prevalent tree species. This low energy benefit can be attributed to crape myrtle which are a small stature tree.

Figure 9: Top Five for Energy Benefits

Table 7: Annual Energy Benefits from Tracy's Most Prevalent Species

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
flowering pear	371.0	78,504	3,415.6	4,338	82,842	10.13	11.39	23.00
Chinese pistache	303.5	64,230	-1,073.3	-1,363	62,866	9.27	8.64	19.07
Raywood ash	372.4	78,791	3,398.7	4,316	83,107	8.10	11.43	28.87
London planetree	419.0	88,655	2,653.3	3,370	92,024	7.78	12.65	33.25
crape myrtle	29.2	6,181	123.4	157	6,338	6.33	0.87	2.82
sweetgum	111.0	23,495	-1,002.0	-1,272	22,222	5.34	3.06	11.70
Chinese hackberry	173.0	36,602	82.0	104	36,706	4.45	5.05	23.22
flowering plum	38.5	8,145	83.5	106	8,251	3.72	1.13	6.24
coast redwood	101.3	21,432	-376.7	-478	20,954	3.02	2.88	19.53
Japanese flowering crabapple	15.0	3,174	59.0	75	3,249	3.00	0.45	3.05
camphor tree	87.8	18,572	-380.0	-483	18,089	2.58	2.49	19.75
Japanese zelkova	92.9	19,653	-343.6	-436	19,217	2.36	2.64	22.90
fruitless mulberry	165.1	34,926	1,568.7	1,992	36,918	2.28	5.08	45.52
Modesto ash	162.4	34,372	1,390.1	1,765	36,138	1.85	4.97	55.00
evergreen pear	57.3	12,132	288.3	366	12,499	1.79	1.72	19.68
ash spp	55.7	11,796	517.4	657	12,454	1.44	1.71	24.32
white ash	13.8	2,919	161.6	205	3,125	1.23	0.43	7.13
northern red oak	15.0	3,164	-71.5	-91	3,074	1.18	0.42	7.30
tallowtree	42.4	8,979	391.4	497	9,476	1.08	1.30	24.68
red maple	28.4	6,009	-178.8	-227	5,782	1.03	0.79	15.76
all other species	708.0	149,811	1,736.2	2,205	152,016	22.03	20.90	19.93
All Species	**3,362.7**	**$711,543**	**12,443.5**	**$15,803**	**$727,346**	**100%**	**100%**	**$20.46**

Aesthetic, Property Value, and Socioeconomic Benefits

Trees provide beauty in the urban landscape, privacy to homeowners, improved human health, a sense of comfort and place, and habitat for urban wildlife. Research shows that trees promote better business by stimulating more frequent and extended shopping and a willingness to pay more for goods and parking (Wolf, 1999). Some of these benefits are captured as a percentage of the value of the property on which a tree stands. To determine the value of these less tangible benefits, i-Tree *Streets* uses research that compares differences in sales prices of homes to estimate the contribution associated with trees. Differences in housing prices in relation to the presence (or lack) of a street tree help define the aesthetic value of street trees in the urban environment.

The calculation of annual aesthetic and other benefits corresponds with a tree's annual increase in leaf area. When a tree is actively growing, leaf area may increase dramatically. Once a tree is mature, there may be little or no net increase in leaf area from one year to the next; thus, there is little or no incremental annual aesthetic benefit for that year, although the cumulative benefit over the course of the entire life of the tree may be large. Since this report represents a one-year sample snapshot of the inventoried tree population, **aesthetic benefits reflect the increase in leaf area for each species population over the course of a single year.**

The total annual benefit from Tracy's public trees associated with property value increases and other less tangible benefits is over $4.1 million, an average of $114.70 per tree (Table 8). Among prevalent species, white ash (*Fraxinus americana*, $323.84) and Chinese hackberry (*Celtis sinensis*, $241.74) provide the greatest per-tree aesthetic value annually (Figure 10).

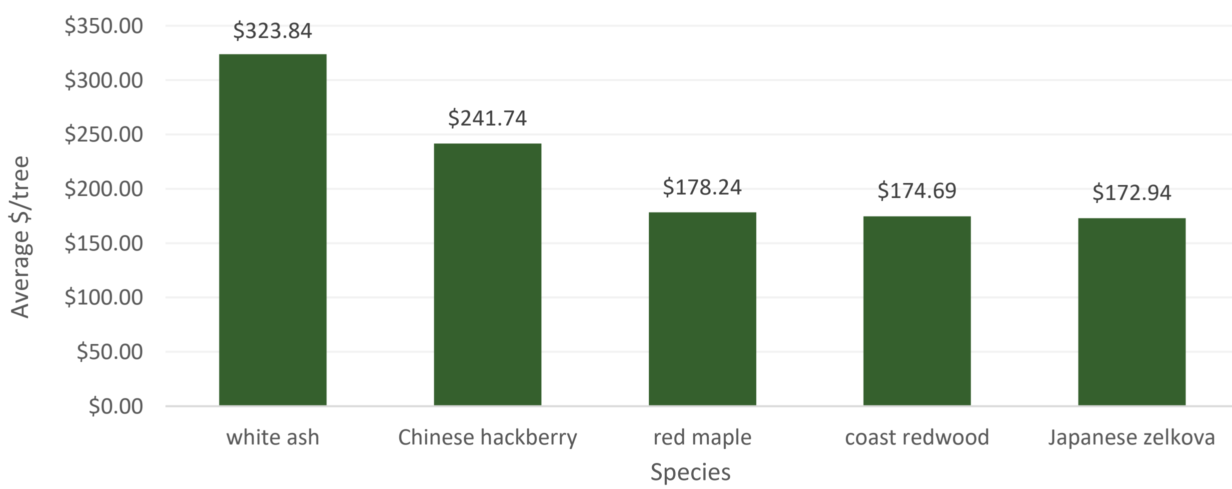

Figure 10: Top Five for Aesthetic Benefits

Table 8: Annual Aesthetic Benefits from Tracy's Most Prevalent Species

Species	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
flowering pear	312,103	10.1	7.7	86.65
Chinese pistache	392,700	9.3	9.6	119.11
Raywood ash	424,584	8.1	10.4	147.48
London planetree	360,728	7.8	8.8	130.32
crape myrtle	39,077	6.3	1.0	17.38
sweetgum	279,308	5.3	6.8	147.00
Chinese hackberry	382,194	4.4	9.4	241.74
flowering plum	22,907	3.7	0.6	17.31
coast redwood	187,442	3.0	4.6	174.69
Japanese flowering crabapple	18,656	3.0	0.5	17.52
camphor tree	121,391	2.6	3.0	132.52
Japanese zelkova	145,101	2.4	3.6	172.94
fruitless mulberry	24,956	2.3	0.6	30.77
Modesto ash	45,412	1.8	1.1	69.12
evergreen pear	65,259	1.8	1.6	102.77
ash spp	42,483	1.4	1.0	82.97
white ash	141,840	1.2	3.5	323.84
northern red oak	41,554	1.2	1.0	98.70
tallowtree	30,905	1.1	0.8	80.48
red maple	65,414	1.0	1.6	178.24
all other species	934,104	22.0	0.2	127.18
All Species	**$4,078,117**	**100%**	**100%**	**$114.70**

Annual Per Tree Cumulative Benefits of Most Prevalent Species

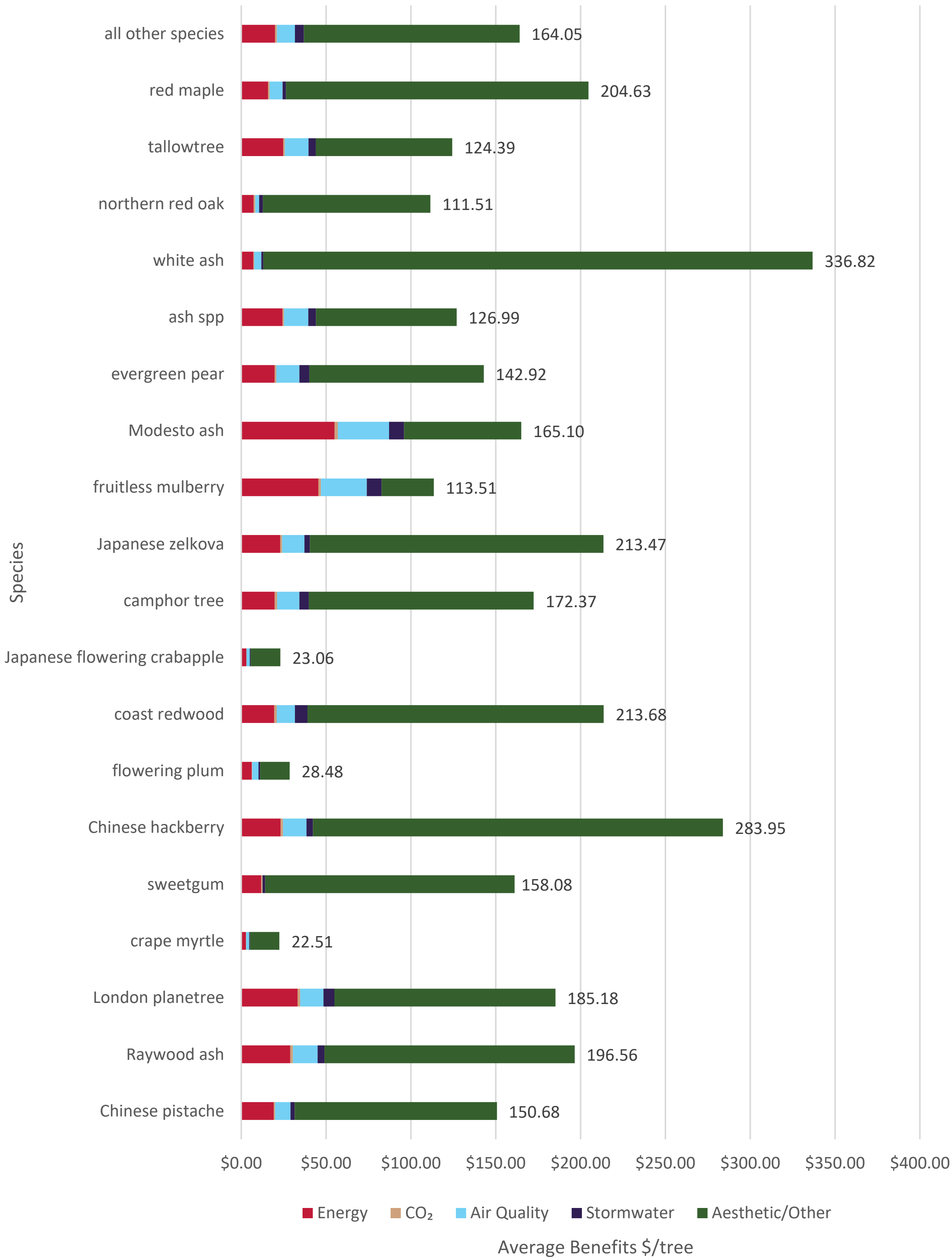

Figure 11: Summary of Annual per Tree Benefits for Most Prevalent Species

Table 9: Summary of Annual Per-Tree Benefits of Prevalent Species

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total	% of Total Population
flowering pear	23.00	0.97	13.04	4.02	86.65	127.67	10.13
Chinese pistache	19.07	0.85	9.06	2.59	119.11	150.68	9.28
Raywood ash	28.87	1.52	14.63	4.07	147.48	196.56	8.10
London planetree	33.25	1.48	13.78	6.35	130.32	185.18	7.79
crape myrtle	2.82	0.11	1.73	0.48	17.38	22.51	6.33
sweetgum	11.70	0.79	-2.97	1.56	147.00	158.08	5.34
Chinese hackberry	23.22	1.41	13.77	3.81	241.74	283.95	4.45
flowering plum	6.24	0.21	3.66	1.06	17.31	28.48	3.72
coast redwood	19.53	1.33	10.73	7.40	174.69	213.68	3.02
Japanese flowering crabapple	3.05	0.12	1.86	0.52	17.52	23.06	3.00
camphor tree	19.75	1.44	13.07	5.58	132.52	172.37	2.58
Japanese zelkova	22.90	1.20	13.13	3.30	172.94	213.47	2.36
fruitless mulberry	45.52	1.35	27.19	8.68	30.77	113.51	2.28
Modesto ash	55.00	1.88	30.26	8.84	69.12	165.10	1.85
evergreen pear	19.68	1.01	13.53	5.93	102.77	142.92	1.79
ash spp	24.32	0.83	14.31	4.55	82.97	126.99	1.44
white ash	7.13	0.55	4.13	1.18	323.84	336.82	1.23
northern red oak	7.30	0.90	2.31	2.30	98.70	111.51	1.08
tallowtree	24.68	1.05	13.93	4.26	80.48	124.39	1.03
red maple	15.76	1.03	7.61	2.00	178.24	204.63	1.19
all other species	19.93	1.03	10.71	5.19	127.18	164.05	22.03
Average	**$20.46**	**$1.02**	**$10.37**	**$3.94**	**$114.70**	**$150.47**	**100%**

Net Benefits and Benefit versus Investment Ratio (BIR)

Tracy receives substantial benefits from their public tree resource (Figure 12); however, managers should examine the investments involved in preserving the public tree resource and the benefits that it provides.

A *benefit-investment ratio* (BIR) is an indicator used to summarize the overall value created compared to the investments of a given resource. For this analysis, BIR is the ratio of the total value of benefits provided by all Tracy trees, compared to the cost associated with their management.

Benefits

Tracy's public tree resource has beneficial effects on the environment. Approximately $1.3 million of the total annual benefits (over $5.4 million) quantified in this study are environmental services (Figure 12). **Annually, Tracy trees provide a total benefit of nearly $5.4 million, a value of $150.47 per tree and $58.87 per capita.** Individual components of the environmental benefits include: stormwater management for $140,123 (2.6%), improved air quality $368,567 (6.9%), carbon reductions of $36,095 (0.7%), and energy savings of $727,346 (13.6%) (Table 10). The remainder of the total annual benefits, over $4.1 million (76.2%), are related to aesthetic and socioeconomic benefits including increased property values.

The total estimated benefits provided by Tracy's public tree resource is nearly $5.4 million, a value of $150.47 per tree and $58.87 per capita. These benefits are realized on an annual basis.

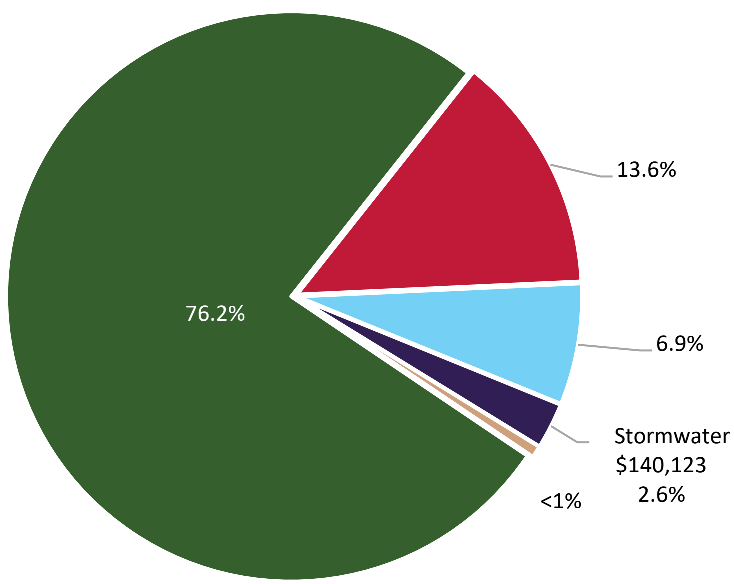

Figure 12: Annual Benefits of Tracy's Public Trees

Total Annual Benefits: $1,403,753

Average Annual Per Tree Benefit: $39.47

A limitation of the annual benefits summary is that it does not fully account for all benefits provided by the public tree resource, as some benefits are intangible and/or difficult to quantify, such as impacts on psychological health, crime, and violence.

Empirical evidence of these benefits does exist (Wolf, 2007; Kaplan, 1989; Ulrich, 1986), but there is limited knowledge about the physical processes at work and the complex nature of interactions make quantification imprecise. Tree growth and mortality rates are highly variable. A true and full accounting of benefits and investments must consider variability among sites (e.g., tree species, growing conditions, maintenance practices) throughout the City, as well as variability in tree growth. In other words, trees are worth far more than what one can ever quantify!

Investment

Investment costs were provided by city staff (Table 10). The total annual cost of managing the public tree resource in Tracy is $1.4 million, the bulk of that cost is associated with contract pruning (35.6%) and removals (21.4%).

Benefit versus Investment Ratio

When Tracy's annual estimated expenditure (or investment) of $1.4 million in this resource is considered, the net annual benefit (benefits minus investment) to the City is $5.4 million. The average net benefit for an individual tree in Tracy is $110.98. Therefore, Tracy is currently receiving $3.81 in benefits for every $1 invested in public trees.

Table 10: Benefits and Investments in the Public Tree Resource of Tracy

Benefits	*Total ($)*	*$/ Tree*	*$/ Capita*
Energy	727,346	20.46	8.00
CO_2	36,095	1.02	0.40
Air Quality	368,567	10.37	4.06
Stormwater	140,123	3.94	1.54
Aesthetic/Other	4,078,117	114.70	44.87
Total Benefits	***$5,350,249***	***$150.47***	***$58.87***
Costs			
Planting	30,000	0.84	0.33
Contract Pruning	500,000	14.06	5.50
Pest Management	10,000	0.28	0.11
Irrigation	1,000	0.03	0.01
Removal	300,000	8.44	3.30
Administration	200,000	5.62	2.20
Inspection/Service	150,000	4.22	1.65
Infrastructure Repairs	30,000	0.84	0.33
Litter Clean-up	180,000	5.06	1.98
Liability/Claims	2,753	0.08	0.03
Total Costs	***$1,403,753***	***$39.47***	***$15.44***
Net Benefits	***$3,946,496***	***$110.98***	***$43.42***
Benefit-Investment ratio	***3.81***		

Conclusion

This analysis describes the current structural characteristics of Tracy's public tree resource, using established numerical modeling and statistical methods to provide a general accounting of the benefits. The analysis provides a "snapshot" of this resource at its current population, structure, and condition. Trees are providing quantifiable impacts on air quality, reduction in atmospheric CO_2, stormwater runoff, and aesthetic benefits. Tracy's 35,561 public trees provide cumulative annual benefits worth $5.4 million, a value of $150.47 per tree and $58.87 per capita.

Tracy's public tree resource has an overall young and established age distribution with 191 distinct species. The City should continue to focus resources on preserving existing and mature trees to promote health, strong structure, and tree longevity. Structural and training pruning for young trees will maximize the value of this resource, reduce long-term maintenance costs, reduce risk, and ensure that as trees mature, they provide the greatest possible benefits over time.

Based on this resource analysis, DRG recommends the following:

- Provide structural pruning for young trees and a regular pruning cycle for all trees.
- Protect existing trees and manage risk with regular inspection to identify and mitigate structural and age-related defects and manage risk and reduce the likelihood of tree and branch failure.
- Increase species diversity in new and replacement tree plantings to reduce reliance on the most prevalent species.
- Continue to maintain and update the inventory database, including tracking tree growth and condition during regular pruning cycles.

Urban forest managers can better anticipate future trends with an understanding of the status of the tree population. Managers can also anticipate challenges and devise plans to increase the current level of benefits. Performance data from this analysis can be used to make determinations regarding species selection, distribution, and maintenance policies. Documenting current structure of public trees is necessary for establishing goals and performance objectives and can serve as a benchmark for measuring future success. Information from the public tree resource analysis can be referenced in development of a public tree resource management or master plan. An urban forest master plan is a critical tool for successful public tree resource management, inspiring commitment and providing vision for communication with key decision-makers both inside and outside the organization.

Tracy's trees are of vital importance to the environmental, social, and economic well-being of the community. City leadership has demonstrated that trees are a valued community resource, a vital component of the City infrastructure, and an important part of the community's identity. The inventory data can be used to plan a proactive and forward-looking approach to the future care of public trees. Updates should continue to be incorporated into the inventory as regular maintenance is performed, including updating the DBH and condition of existing trees. Current and complete inventory data will help staff to more efficiently track maintenance activities and tree health and will provide a strong basis for making informed management decisions. A continued commitment to planting, maintaining, and preserving these trees, will support the health, and welfare of the city and community at large.

Trees surrounding the courtyard outside City Hall.

Appendix A: Methodology

In 2018, the City of Tracy provided the City's public tree inventory data to Davey Resource Group. This inventory included details about each tree, including species, size, and condition. DRG formatted the data for use in i-Tree *Streets*, a STRATUM Analysis Tool (Streets v 5.1.5; i-Tree v 6.1.15). i-Tree *Streets* assesses tree population structure and the function of those trees, such as their role in energy use, air pollution removal, stormwater interception, carbon dioxide removal, and property value increases. To analyze the economic benefits of Tracy's public trees, i-Tree *Streets* calculates the dollar value of annual resource functionality. This analysis combines the results of the tree inventory with benefit modeling data to produce information regarding resource structure, function, and value for use in determining management recommendations. i-Tree *Streets* regionalizes the calculations of its output by incorporating detailed reference city project information for 17 climate zones across the United States. Tracy is in the Inland Valleys Climate Zone. The reference city is Modesto, California.

An annual resource unit was determined on a per tree basis for each of the modeled benefits. Resource units are measured as MWh of electricity saved per tree; MBtu of natural gas conserved per tree; pounds of atmospheric CO_2 reduced per tree; pounds of NO_2, SO_2, O_3, PM_{10}, and VOCs reduced per tree; cubic feet of stormwater runoff reduced per tree; and square feet of leaf area added per tree to increase property values. Price values assigned to each resource unit (tree) were generated based on economic indicators of society's willingness to pay for the environmental benefits trees provide. The City of Tracy provided the estimated investment costs.

Estimates of benefits are initial approximations as some benefits are difficult to quantify (e.g. impacts on psychological health, crime, and violence). In addition, limited knowledge about the physical processes at work and their interactions makes estimates imprecise (e.g., fate of air pollutants trapped by trees and then washed to the ground by rainfall). Therefore, this method of quantification provides first-order approximations based on current research. It is intended to be a general accounting of the benefits produced by urban trees.

i-Tree *Streets* default values (Table 11) from the Inland Valley Climate Zone were used for all benefit prices except for the median home value, and electrical and natural gas rates. Using these rates, the magnitude of the benefits provided by the public tree resource was calculated using i-Tree *Streets***.** Electrical and gas rates, and program investment costs were supplied by public tree resource managers for Tracy.

Table 11: Benefit Prices Used in This Analysis

Benefits	Price	Unit	Source
Electricity	0.21169	$/Kwh	Pacific Gas and Electric Company
Natural Gas	1.27	$/Therms	Pacific Gas and Electric Company
CO_2	0.0075	$/lb	i-Tree Default
PM_{10}	9.41	$/lb	i-Tree Default
NO_2	12.79	$/lb	i-Tree Default
SO_2	3.72	$/lb	i-Tree Default
VOC	4.69	$/lb	i-Tree Default
Stormwater Interception	0.0078	$/gallon	i-Tree Default
Median Home Price	542,000	$	Corelogic.com

For every $1 invested in public trees, Tracy receives $3.81 in benefits.

Appendix B: References

Akbari H, Davis S, Dorsano S, Huang J, Winnett S, eds. 1992. Cooling Our Communities: A Guidebook on Tree Planting and Light-Colored Surfacing. Washington, DC. U.S. Environmental Protection Agency. 26 p.

Bell ML, McDermott A, Zeger SL, Samet JM, Dominici F. 2004. Ozone and Short-Term Mortality in 95 US Urban Communities, 1987-2000. Journal of the American Medical Association 292:2372-2378.

Chandler TJ. 1965. The Climate of London. London UK. Hutchinson.

Clark JR, Matheny NP, Cross G, Wake V. 1997. A Model of Urban Forest Sustainability. Journal of Arboriculture 23(1):17-30.

CTLA. 1992. Guide for Plant Appraisal. 8th ed. Savoy, IL: ISA. 103 p.

CUFR. 2017. Center for Urban Forest Research Pacific Southwest Research Station. *http://www.fs.fed.us/psw/programs/cufr/*

Cullen S. 2002. Tree Appraisal: Can Depreciation Factors Be Rated Greater than 100%? Journal of Arboriculture 28(3):153-158.

EPA, 2013. US Environmental Protection Agency. Environmental Topics. Heat Island Effect. www.epa.gov/heatisland/about/index.htm

Eskalen, A. 2015, October 19. Polyphagous and Kuroshio Shot Hole Borers. Retrieved August 2, 2018, from http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=19197

Hauer, Richard. (2014). Species Diversity is a Numbers Game and More. Arborist News. 23. 34-39.

Heisler GM. 1986. Energy Savings with Trees. Journal of Arboriculture 12(5):113–125.

i-Tree, Streets, http://www.itreetools.org/

Kaplan R, Kaplan S. 1989. The Experience of Nature: A Psychological Perspective. Cambridge: Cambridge University Press.

Maco SE, McPherson EG. 2003. A Practical Approach to Assessing Structure, Function, and Value of Street Tree Populations in Small Communities. Journal of Arboriculture 29(2):84-97.

McPherson EG, Rowntree RA. 1989. Using Structural Measures to Compare Twenty-two US Street Tree Populations. Landscape Journal 8:13-23.

McPherson EG. 1993. Evaluating the Cost-Effectiveness of Shade Trees for Demand-Side Management. Electricity Journal 6(9):57-65.

Richards NA. 1982/83. Diversity and Stability in a Street Tree Population. Urban Ecology. 7:159–171.

S Santamour, Frank. (1990). Trees for urban planting: Diversity, uniformity and common sense. Proceedings of the 7th Conference of the Metropolitan Tree Improvement Alliance. 7.

Simpson JR. 1998. Urban Forest Impacts on Regional Space Conditioning Energy Use: Sacramento County Case Study. Journal of Arboriculture 24(4): 201–214.

Ulrich, RS. 1986. Human Responses to Vegetation and Landscapes. Landscape and Urban Planning, 13, 29-44.

Watson G. 2002. Comparing Formula Methods of Tree Appraisal. Journal of Arboriculture 28(1): 11-18.

Wolf, K. L. 1999. Nature and Commerce: Human Ecology in Business Districts. In C. Kollin (ed.) Building Cities of Green: Proceedings of the 9th Nationl11 Urban Forest Conference. Washington D.C.: American Forests.

Wolf, K.L. 2007. The Environmental Psychology of Trees. International Council of Shopping Centers Research Review. 14, 3:39-43.

Appendix C: Tables

Table 12: Common and Botanical Species Names

Common Name	Botanical Name	Count
acacia	*Acacia spp*	15
African sumac	*Rhus lancea*	90
alder species	*Alnus species*	14
Aleppo pine	*Pinus halepensis*	177
almond	*Prunus dulcis*	2
American elm	*Ulmus americana*	2
American plum	*Prunus americana*	1
araucaria	*Araucaria spp*	7
ash spp	*Fraxinus spp*	512
Asian bayberry	*Nageia nagi*	34
atlas cedar	*Cedrus atlantica*	24
Australian willow	*Geijera parviflora*	1
autumn blaze maple	*Acer x freemanii 'Jeffersred'*	16
beefwood spp	*Casuarina spp*	6
birch	*Betula spp*	6
bird of paradise	*Caesalpinia spinosa*	1
bird of paradise bush	*Caesalpinia gilliesii*	10
black locust	*Robinia pseudoacacia*	39
black tupelo	*Nyssa sylvatica*	135
black walnut	*Juglans nigra*	14
blackwood	*Accacia melanoxylon*	1
blue oak	*Quercus douglasii*	3
bottlebrush	*Callistemon spp*	9
boxelder	*Acer negundo*	7
Brazilian pepper	*Schinus terbinthifolius*	9
brisbane box	*Lophostemon confertus*	1
bronze loquat	*Eriobotrya deflexa*	11
burr oak	*Quercus macrocarpa*	4
California buckeye	*Aesculus californica*	1
California laurel	*Umbellularia californica*	110
California peppertree	*Schinus molle*	147
callery pear 'Aristocrat'	*Pyrus calleryana 'Aristocrat'*	36
callery pear 'Bradford'	*Pyrus calleryana 'Bradford'*	4
camphor tree	*Cinnamomum camphora*	916
Canary Island pine	*Pinus canariensis*	153
Carob	*Ceratonia siliqua*	84
carrotwood	*Cupaniopsis anacardioides*	5
Catalina cherry	*Prunus ilicifolia ssp lyonii*	12
catalpa	*Catalpa spp*	7
cedar elm	*Ulmus crassifolia*	4
cheesewood	*Pittosporum spp*	1

Common Name	Botanical Name	Count
cherry laurel	*Prunus caroliniana*	12
chinaberry	*Melia azedarach*	8
Chinese elm	*Ulmus parvifolia*	200
Chinese fringe tree	*Chionanthus retusus*	17
Chinese hackberry	*Celtis sinensis*	1,581
Chinese photinia	*Photinia serrulata*	1
Chinese pistache	*Pistacia chinensis*	3,298
chitalpa	*Chitalpa tashkentensis*	19
citrus	*Citrus spp*	9
coast redwood	*Sequoia sempervirens*	1,073
coastal live oak	*Quercus agrifolia*	80
common privet	*Ligustrum vulgare*	13
coolibah	*Eucalyptus microtheca*	1
cork oak	*Quercus suber*	39
cottonwood	*Populus species*	2
crape myrtle	*Lagerstroemia indica*	2,249
cypress	*Cupressus spp*	6
deodar cedar	*Cedrus deodara*	326
eastern redbud	*Cercis canadensis*	68
elm	*Ulmus species*	72
English elm	*Ulmus procera*	2
English laurel	*Prunus laurocerasus*	14
English walnut	*Juglans regia*	1
European hackberry	*Celtis australis*	4
European hornbeam	*Carpinus betulus*	27
evergreen ash	*Fraxinus uhdei*	282
evergreen pear	*Pyrus kawakamii*	635
fern pine	*Afrocarpus gracilior*	1
fig	*Ficus spp*	1
flame tree	*Koelreuteria bipinnata*	35
flowering cherry	*Prunus campanulata*	1
flowering crabapple	*Malus species*	316
flowering pear	*Pyrus calleryana*	3,602
flowering plum	*Prunus blireana*	64
flowering plum	*Prunus cerasifera*	1,323
fountain palm	*Livistona spp*	2
fraser photinia	*Photinia x fraseri*	120
Fremont cottonwood	*Populus fremontii*	53
fruitless mulberry	*Morus alba*	811
ginkgo	*Ginkgo biloba*	140
ginkgo 'Autumn Gold'	*Ginkgo biloba 'Autumn Gold'*	93
goldenrain tree	*Koelreuteria paniculata*	110
green ash	*Fraxinus pennsylvanica*	9
gum	*Eucalyptus species*	116
hackberry	*Celtis species*	2

Common Name	Botanical Name	Count
hawthorn	*Crataegus spp*	16
hind walnut	*Juglans hindsii*	1
holly oak	*Quercus ilex*	77
Hollywood juniper	*Juniperus chinensis 'Torulosa'*	2
honeylocust	*Gleditsia triacanthos*	80
hornbeam	*Carpinus spp*	48
Idaho locust	*Robinia ambigua idahoensis*	6
incense cedar	*Calocedrus decurrens*	38
Indian hawthorne	*Rhaphiolepis 'Majestic Beauty'*	29
interior live oak	*Quercus wislizeni*	2
Italian alder	*Alnus cordata*	47
Italian cypress	*Cupressus sempervirens*	53
Italian stone pine	*Pinus pinea*	6
Japanese black pine	*Pinus thunbergiana*	10
Japanese flowering cherry	*Prunus serrulata*	193
Japanese flowering crabapple	*Malus floribunda*	1,065
Japanese maple	*Acer palmatum*	2
Japanese pagoda tree	*Sophora japonica*	99
Japanese zelkova	*Zelkova serrata*	839
Japanese zelkova 'Village Green'	*Zelkova serrata 'Village Green'*	19
juniper	*Juniperus species*	2
koelreuteria spp	*Koelreuteria spp*	4
laurel de olor	*Laurus nobilis*	151
lemon-scented gum	*Corymbia citriodora*	3
Leyland cypress	*Cupressocyparis x leylandii*	11
little-leaf linden	*Tilia cordata*	243
locust	*Gleditsia species*	55
Lombardy poplar	*Populus nigra italica*	27
London planetree	*Platanus X acerifolia*	2,770
London planetree 'Bloodgood'	*Platanus acerifolia 'Bloodgood'*	11
loquat tree	*Eriobotrya japonica*	1
magnolia	*Magnolia species*	2
maple	*Acer spp*	22
marina arbutus	*Arbutus marina*	6
mayten tree	*Maytenus boaria*	106
Mexican fan palm	*Washingtonia robusta*	1
mimosa	*Albizia julibrissin*	145
Modesto ash	*Fraxinus velutina 'Modesto'*	657
Mondell pine	*Pinus eldarica*	106
Monterey pine	*Pinus radiata*	120
moraine ash	*Fraxinus holotricha*	116
mulberry	*Morus spp*	162
ngaio	*Myoporum laetum*	4
northern hackberry	*Celtis occidentalis*	23
northern red oak	*Quercus rubra*	422

Common Name	Botanical Name	Count
oak	*Quercus species*	11
oleander	*Nerium oleander*	5
olive	*Olea europaea*	10
peach	*Prunus persica*	7
pecan	*Carya illinoensis*	13
Peruvian pepper	*Schinus polygamus*	1
pin oak	*Quercus palustris*	127
pincushion tree	*Hakea laurina*	6
pine	*Pinus spp*	9
plum	*Prunus spp*	73
privet	*ligustrum spp*	237
purple ash	*Fraxinus americana 'Purple Ash'*	5
purple robe locust	*Robinia pseudoacacia 'Purple Robe'*	102
purple smoke tree	*Cotinus coggygria*	5
Raywood ash	*Fraxinus angustifolia 'Raywood'*	2,879
red gum	*Eucalyptus camaldulensis*	1
red ironbark	*Eucalyptus sideroxylon*	7
red maple	*Acer rubrum*	367
red willow	*Salix laevigata*	1
redbud	*Cercis spp*	112
rosehill ash	*Fraxinus americana 'Rosehill'*	1
rusty-leaf fig	*Ficus rubiginosa*	1
saucer magnolia	*Magnolia x soulangiana*	6
scarlet oak	*Quercus coccinea*	140
Shumard red oak	*Quercus shumardii*	8
Siberian elm	*Ulmus pumila*	16
silk oak	*Grevillea robusta*	45
silver dollar gum eucalyptus	*Eucalyptus polyanthemos*	23
silver maple	*Acer saccharinum*	2
smooth hawthorn	*Crataegus laevigata*	23
southern live oak	*Quercus virginiana*	139
southern magnolia	*Magnolia grandiflora*	99
spruce spp	*Picea spp*	1
strawberry tree	*Arbutus unedo*	194
swamp mahogany	*Euctalyptus robusta*	1
sweet almond	*Prunus amygdalus*	9
sweetgum	*Liquidambar styraciflua*	1,900
sycamore spp	*Platanus spp*	5
tallowtree	*Triadica sebifera*	384
tree of heaven	*Ailanthus altissima*	4
trident maple	*Acer buergerianum*	1
tulip tree	*Liriodendron tulipifera*	202
Turkish pine	*Pinus brutia*	16
UNIDENTIFIED TREE	*Unidentified species*	4
UNKNOWN	*Unknown*	1

Common Name	Botanical Name	Count
upright European hornbeam	*Carpinus betulus 'Fastigiata'*	18
valley oak	*Quercus lobata*	92
velvet ash	*Fraxinus velutina*	47
walnut	*Juglans spp*	4
Washington hawthorn	*Crataegus phaenopyrum*	129
water gum	*Tristaniopsis laurina*	3
waterbrush	*Myoporum acuminatum*	1
weeping fig	*Ficus microcarpa 'Variegata'*	1
weeping willow	*Salix babylonica*	21
western sycamore	*Platanus racemosa*	120
white alder	*Alnus rhombifolia*	106
white ash	*Fraxinus americana*	438
willow	*Salix species*	45
xylosma	*Xylosma congestum*	58
yucca spp	*Yucca spp*	4
	Total	***35,561***

Table 13: Importance Value for All Tree Species

Species	Number of Trees	% of Total Trees	Leaf Area (ft²)	% of Total Leaf Area	Canopy Cover (ft²)	% of Total Canopy Cover	Importance Value
flowering pear	3,602	10.1	5,486,665	9.6	1,997,191	10.8	**10.2**
Chinese pistache	3,297	9.3	3,546,667	6.2	1,613,906	8.7	**8.1**
Raywood ash	2,879	8.1	7,050,536	12.4	1,932,908	10.5	**10.3**
London planetree	2,768	7.8	6,674,961	11.7	2,438,082	13.2	**10.9**
crape myrtle	2,249	6.3	489,238	0.9	198,895	1.1	**2.8**
sweetgum	1,900	5.3	2,282,276	4.0	464,881	2.5	**4.0**
Chinese hackberry	1,581	4.4	3,291,915	5.8	989,129	5.4	**5.2**
flowering plum	1,323	3.7	760,132	1.3	244,962	1.3	**2.1**
coast redwood	1,073	3.0	2,141,387	3.8	471,444	2.6	**3.1**
Japanese flowering crabapple	1,065	3.0	257,529	0.5	101,189	0.5	**1.3**
camphor tree	916	2.6	1,143,199	2.0	443,944	2.4	**2.3**
Japanese zelkova	839	2.4	1,345,257	2.4	519,657	2.8	**2.5**
fruitless mulberry	811	2.3	2,751,018	4.8	946,063	5.1	**4.1**

Species	Number of Trees	% of Total Trees	Leaf Area (ft²)	% of Total Leaf Area	Canopy Cover (ft²)	% of Total Canopy Cover	Importance Value
Modesto ash	657	1.8	3,288,660	5.8	981,570	5.3	**4.3**
evergreen pear	635	1.8	828,826	1.5	320,167	1.7	**1.7**
ash spp	512	1.4	917,490	1.6	313,442	1.7	**1.6**
white ash	438	1.2	283,675	0.5	90,224	0.5	**0.7**
northern red oak	421	1.2	222,921	0.4	81,484	0.4	**0.7**
tallowtree	384	1.1	614,305	1.1	227,135	1.2	**1.1**
red maple	367	1.0	334,901	0.6	134,852	0.7	**0.8**
deodar cedar	326	0.9	589,825	1.0	138,196	0.7	**0.9**
flowering crabapple	316	0.9	76,351	0.1	30,008	0.2	**0.4**
evergreen ash	282	0.8	630,780	1.1	230,182	1.2	**1.0**
little-leaf linden	243	0.7	364,349	0.6	106,519	0.6	**0.6**
privet	237	0.7	350,352	0.6	135,556	0.7	**0.7**
tulip tree	202	0.6	188,345	0.3	38,759	0.2	**0.4**
Chinese elm	200	0.6	239,347	0.4	121,663	0.7	**0.5**
strawberry tree	194	0.5	132,863	0.2	44,394	0.2	**0.3**
Japanese flowering cherry	193	0.5	113,974	0.2	36,571	0.2	**0.3**
Aleppo pine	177	0.5	712,563	1.2	188,545	1.0	**0.9**
mulberry	162	0.5	574,069	1.0	196,287	1.1	**0.8**
Canary Island pine	153	0.4	346,076	0.6	81,078	0.4	**0.5**
laurel de olor	151	0.4	32,016	0.1	12,304	0.1	**0.2**
California peppertree	147	0.4	764,429	1.3	150,639	0.8	**0.9**
mimosa	145	0.4	201,401	0.4	74,098	0.4	**0.4**
scarlet oak	140	0.4	84,321	0.1	31,923	0.2	**0.2**
southern live oak	139	0.4	174,096	0.3	62,039	0.3	**0.3**
ginkgo	139	0.4	70,012	0.1	19,906	0.1	**0.2**
black tupelo	135	0.4	50,262	0.1	12,937	0.1	**0.2**
Washington hawthorn	129	0.4	26,257	0.0	10,919	0.1	**0.2**
pin oak	127	0.4	70,993	0.1	26,185	0.1	**0.2**
Monterey pine	120	0.3	312,548	0.5	72,816	0.4	**0.4**
western sycamore	120	0.3	190,260	0.3	60,065	0.3	**0.3**
fraser photinia	120	0.3	65,413	0.1	20,159	0.1	**0.2**
gum	116	0.3	426,721	0.7	125,526	0.7	**0.6**

Species	Number of Trees	% of Total Trees	Leaf Area (ft^2)	% of Total Leaf Area	Canopy Cover (ft^2)	% of Total Canopy Cover	Importance Value
moraine ash	116	0.3	227,443	0.4	65,604	0.4	**0.4**
redbud	112	0.3	21,451	0.0	9,116	0.0	**0.1**
goldenrain tree	110	0.3	115,456	0.2	47,293	0.3	**0.3**
California laurel	110	0.3	35,198	0.1	10,811	0.1	**0.1**
white alder	106	0.3	315,196	0.6	110,071	0.6	**0.5**
Mondell pine	106	0.3	263,082	0.5	60,019	0.3	**0.4**
mayten tree	106	0.3	58,755	0.1	26,253	0.1	**0.2**
purple robe locust	102	0.3	117,773	0.2	63,921	0.3	**0.3**
Japanese pagoda tree	99	0.3	161,670	0.3	72,489	0.4	**0.3**
southern magnolia	99	0.3	51,885	0.1	18,184	0.1	**0.2**
ginkgo 'Autumn Gold'	93	0.3	19,801	0.0	7,700	0.0	**0.1**
valley oak	92	0.3	247,732	0.4	67,849	0.4	**0.4**
African sumac	90	0.3	171,870	0.3	66,631	0.4	**0.3**
Carob	84	0.2	601,251	1.1	164,043	0.9	**0.7**
coastal live oak	80	0.2	99,109	0.2	32,591	0.2	**0.2**
honeylocust	80	0.2	79,832	0.1	38,777	0.2	**0.2**
holly oak	77	0.2	47,121	0.1	18,756	0.1	**0.1**
plum	73	0.2	13,111	0.0	5,706	0.0	**0.1**
elm	72	0.2	580,759	1.0	114,013	0.6	**0.6**
eastern redbud	68	0.2	20,604	0.0	7,588	0.0	**0.1**
flowering plum	64	0.2	26,876	0.0	9,169	0.0	**0.1**
xylosma	58	0.2	66,889	0.1	24,956	0.1	**0.1**
locust	55	0.2	221,026	0.4	71,214	0.4	**0.3**
Fremont cottonwood	53	0.1	286,103	0.5	82,084	0.4	**0.4**
Italian cypress	53	0.1	16,263	0.0	5,214	0.0	**0.1**
hornbeam	48	0.1	53,900	0.1	20,113	0.1	**0.1**
Italian alder	47	0.1	92,758	0.2	34,302	0.2	**0.2**
velvet ash	47	0.1	38,559	0.1	12,828	0.1	**0.1**
willow	45	0.1	152,396	0.3	52,094	0.3	**0.2**
silk oak	45	0.1	67,781	0.1	25,840	0.1	**0.1**
black locust	39	0.1	290,540	0.5	73,906	0.4	**0.3**
cork oak	39	0.1	116,469	0.2	25,874	0.1	**0.2**
incense cedar	38	0.1	25,920	0.0	6,156	0.0	**0.1**
callery pear 'Aristocrat'	36	0.1	43,902	0.1	16,278	0.1	**0.1**

Species	Number of Trees	% of Total Trees	Leaf Area (ft²)	% of Total Leaf Area	Canopy Cover (ft²)	% of Total Canopy Cover	Importance Value
flame tree	35	0.1	122,234	0.2	27,474	0.1	**0.2**
Asian bayberry	34	0.1	27,643	0.0	9,640	0.1	**0.1**
Indian hawthorne	29	0.1	10,571	0.0	2,613	0.0	**0.0**
Lombardy poplar	27	0.1	175,759	0.3	47,637	0.3	**0.2**
European hornbeam	27	0.1	34,040	0.1	12,793	0.1	**0.1**
atlas cedar	24	0.1	31,694	0.1	6,556	0.0	**0.1**
silver dollar gum eucalyptus	23	0.1	79,246	0.1	23,468	0.1	**0.1**
northern hackberry	23	0.1	15,696	0.0	3,477	0.0	**0.0**
smooth hawthorn	23	0.1	7,152	0.0	2,616	0.0	**0.0**
maple	22	0.1	19,682	0.0	7,736	0.0	**0.0**
weeping willow	21	0.1	73,130	0.1	24,737	0.1	**0.1**
chitalpa	19	0.1	12,732	0.0	4,010	0.0	**0.0**
Japanese zelkova 'Village Green'	19	0.1	5,223	0.0	2,483	0.0	**0.0**
upright European hornbeam	18	0.1	12,791	0.0	4,351	0.0	**0.0**
Chinese fringe tree	17	0.0	2,731	0.0	1,242	0.0	**0.0**
Siberian elm	16	0.0	245,566	0.4	36,470	0.2	**0.2**
Turkish pine	16	0.0	65,394	0.1	9,189	0.0	**0.1**
autumn blaze maple	16	0.0	6,149	0.0	2,120	0.0	**0.0**
hawthorn	16	0.0	4,645	0.0	1,730	0.0	**0.0**
acacia	15	0.0	5,730	0.0	2,091	0.0	**0.0**
black walnut	14	0.0	73,833	0.1	22,393	0.1	**0.1**
alder species	14	0.0	27,188	0.0	9,838	0.1	**0.0**
English laurel	14	0.0	7,511	0.0	2,300	0.0	**0.0**
pecan	13	0.0	70,757	0.1	20,230	0.1	**0.1**
common privet	13	0.0	16,321	0.0	6,278	0.0	**0.0**
cherry laurel	12	0.0	9,992	0.0	3,504	0.0	**0.0**
Catalina cherry	12	0.0	7,459	0.0	2,375	0.0	**0.0**
oak	11	0.0	23,825	0.0	5,668	0.0	**0.0**

Species	Number of Trees	% of Total Trees	Leaf Area (ft²)	% of Total Leaf Area	Canopy Cover (ft²)	% of Total Canopy Cover	Importance Value
Leyland cypress	11	0.0	13,888	0.0	2,865	0.0	**0.0**
London planetree 'Bloodgood'	11	0.0	4,253	0.0	1,174	0.0	**0.0**
bronze loquat	11	0.0	4,010	0.0	991	0.0	**0.0**
olive	10	0.0	19,769	0.0	6,192	0.0	**0.0**
bird of paradise bush	10	0.0	11,786	0.0	4,449	0.0	**0.0**
Japanese black pine	10	0.0	5,047	0.0	1,792	0.0	**0.0**
green ash	9	0.0	25,480	0.0	9,170	0.0	**0.0**
pine	9	0.0	24,035	0.0	5,665	0.0	**0.0**
Brazilian pepper	9	0.0	7,644	0.0	3,670	0.0	**0.0**
almond	9	0.0	3,520	0.0	1,219	0.0	**0.0**
bottlebrush	9	0.0	3,281	0.0	811	0.0	**0.0**
citrus	9	0.0	3,281	0.0	811	0.0	**0.0**
chinaberry	8	0.0	28,141	0.0	9,680	0.1	**0.0**
Shumard red oak	8	0.0	1,516	0.0	358	0.0	**0.0**
red ironbark	7	0.0	50,903	0.1	11,262	0.1	**0.1**
boxelder	7	0.0	16,645	0.0	6,146	0.0	**0.0**
catalpa	7	0.0	14,909	0.0	4,670	0.0	**0.0**
araucaria	7	0.0	7,374	0.0	1,575	0.0	**0.0**
peach	7	0.0	2,507	0.0	886	0.0	**0.0**
pincushion tree	6	0.0	10,899	0.0	4,161	0.0	**0.0**
beefwood spp	6	0.0	14,010	0.0	2,884	0.0	**0.0**
Italian stone pine	6	0.0	11,754	0.0	2,480	0.0	**0.0**
Idaho locust	6	0.0	5,603	0.0	3,257	0.0	**0.0**
birch	6	0.0	6,052	0.0	1,632	0.0	**0.0**
marina arbutus	6	0.0	4,344	0.0	2,175	0.0	**0.0**
cypress	6	0.0	3,867	0.0	934	0.0	**0.0**
saucer magnolia	6	0.0	1,331	0.0	424	0.0	**0.0**
carrotwood	5	0.0	14,546	0.0	5,701	0.0	**0.0**
purple ash	5	0.0	4,804	0.0	1,696	0.0	**0.0**
oleander	5	0.0	3,543	0.0	1,230	0.0	**0.0**
sycamore spp	5	0.0	3,314	0.0	721	0.0	**0.0**
purple smoke tree	5	0.0	803	0.0	365	0.0	**0.0**
cedar elm	4	0.0	41,890	0.1	6,751	0.0	**0.0**

Species	Number of Trees	% of Total Trees	Leaf Area (ft²)	% of Total Leaf Area	Canopy Cover (ft²)	% of Total Canopy Cover	Importance Value
walnut	4	0.0	23,668	0.0	6,547	0.0	**0.0**
burr oak	4	0.0	9,648	0.0	3,070	0.0	**0.0**
ngaio	4	0.0	6,732	0.0	2,604	0.0	**0.0**
koelreuteria spp	4	0.0	6,717	0.0	2,505	0.0	**0.0**
tree of heaven	4	0.0	6,603	0.0	2,286	0.0	**0.0**
callery pear 'Bradford'	4	0.0	6,175	0.0	2,279	0.0	**0.0**
European hackberry	4	0.0	5,141	0.0	1,452	0.0	**0.0**
Unidentified tree	4	0.0	5,818	0.0	985	0.0	**0.0**
yucca spp	4	0.0	480	0.0	255	0.0	**0.0**
water gum	3	0.0	1,896	0.0	616	0.0	**0.0**
blue oak	3	0.0	1,309	0.0	194	0.0	**0.0**
lemon-scented gum	3	0.0	568	0.0	134	0.0	**0.0**
American elm	2	0.0	26,221	0.0	4,878	0.0	**0.0**
English elm	2	0.0	14,256	0.0	3,097	0.0	**0.0**
cottonwood	2	0.0	6,183	0.0	1,832	0.0	**0.0**
silver maple	2	0.0	4,976	0.0	2,033	0.0	**0.0**
hackberry	2	0.0	4,824	0.0	1,535	0.0	**0.0**
fountain palm	2	0.0	2,273	0.0	1,710	0.0	**0.0**
interior live oak	2	0.0	2,050	0.0	818	0.0	**0.0**
juniper	2	0.0	1,582	0.0	371	0.0	**0.0**
Japanese maple	2	0.0	769	0.0	265	0.0	**0.0**
magnolia	2	0.0	444	0.0	141	0.0	**0.0**
almond	2	0.0	321	0.0	146	0.0	**0.0**
Hollywood juniper	2	0.0	298	0.0	78	0.0	**0.0**
coolibah	1	0.0	36,485	0.1	2,530	0.0	**0.0**
red gum	1	0.0	14,815	0.0	2,401	0.0	**0.0**
hind walnut	1	0.0	5,746	0.0	1,768	0.0	**0.0**
red willow	1	0.0	5,746	0.0	1,768	0.0	**0.0**
UNKNOWN	1	0.0	2,110	0.0	385	0.0	**0.0**
English walnut	1	0.0	1,175	0.0	441	0.0	**0.0**
California buckeye	1	0.0	1,175	0.0	441	0.0	**0.0**
bird of paradise	1	0.0	1,167	0.0	436	0.0	**0.0**
cheesewood	1	0.0	1,167	0.0	436	0.0	**0.0**
waterbrush	1	0.0	1,167	0.0	436	0.0	**0.0**

Species	Number of Trees	% of Total Trees	Leaf Area (ft²)	% of Total Leaf Area	Canopy Cover (ft²)	% of Total Canopy Cover	Importance Value
spruce spp	1	0.0	1,360	0.0	277	0.0	**0.0**
fig	1	0.0	724	0.0	362	0.0	**0.0**
brisbane box	1	0.0	724	0.0	362	0.0	**0.0**
blackwood	1	0.0	767	0.0	329	0.0	**0.0**
swamp mahogany	1	0.0	767	0.0	329	0.0	**0.0**
flowering cherry	1	0.0	852	0.0	260	0.0	**0.0**
trident maple	1	0.0	384	0.0	132	0.0	**0.0**
rosehill ash	1	0.0	401	0.0	107	0.0	**0.0**
loquat tree	1	0.0	365	0.0	90	0.0	**0.0**
Chinese photinia	1	0.0	365	0.0	90	0.0	**0.0**
Australian willow	1	0.0	365	0.0	90	0.0	**0.0**
American plum	1	0.0	161	0.0	73	0.0	**0.0**
weeping fig	1	0.0	172	0.0	59	0.0	**0.0**
Peruvian pepper	1	0.0	172	0.0	59	0.0	**0.0**
fern pine	1	0.0	172	0.0	59	0.0	**0.0**
rusty-leaf fig	1	0.0	172	0.0	59	0.0	**0.0**
Mexican fan palm	1	0.0	120	0.0	64	0.0	**0.0**
Total	**35,556**	**100%**	**57,034,856**	**100%**	**18,472,334**	**100%**	**100.0**