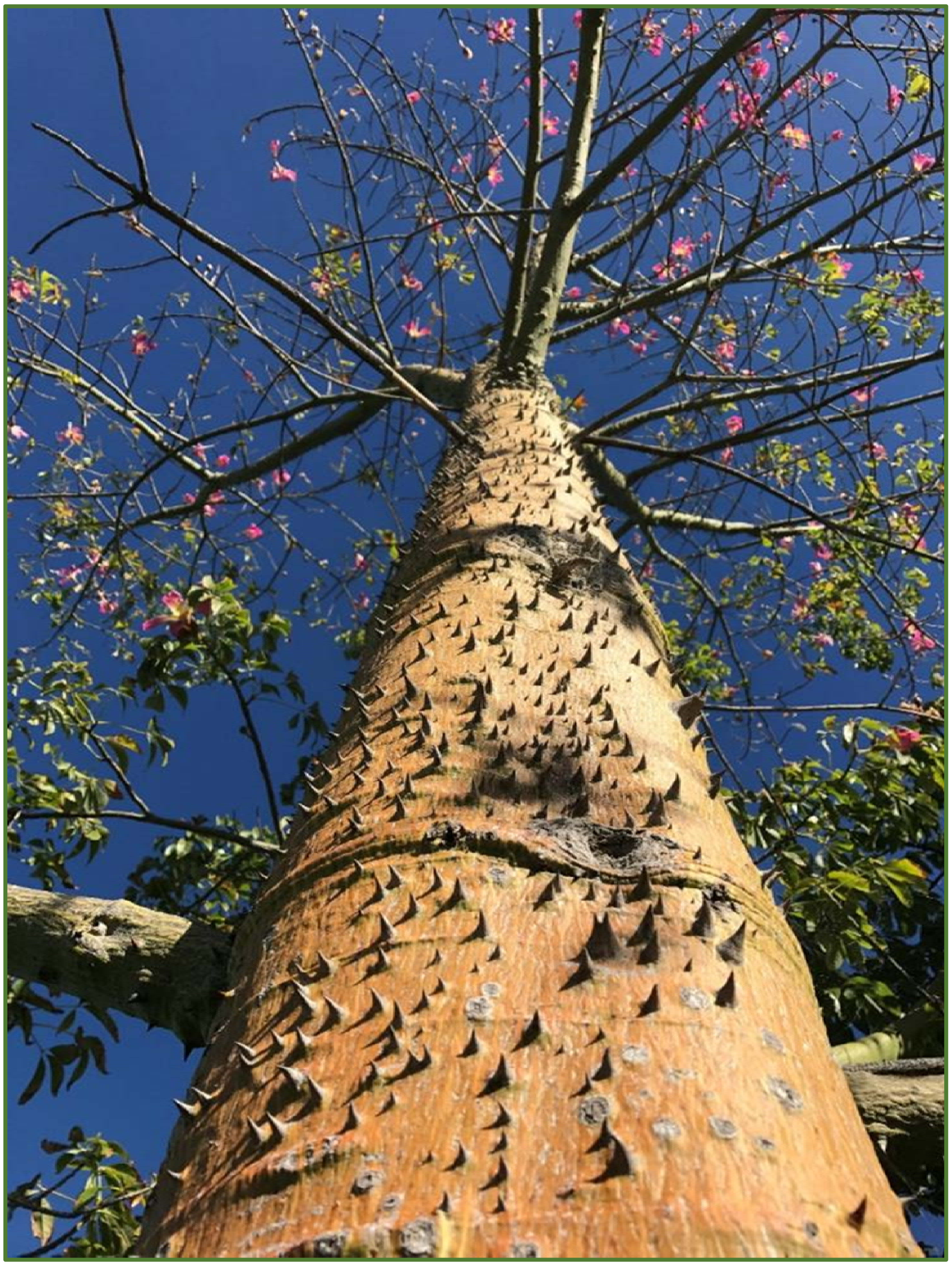
Urban Forest Resource Analysis
Los Altos, California

2017



Los Altos

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DAVEY RESOURCE GROUP
A Division of The Davey Tree Expert Company

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Los Altos, California

2017

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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 STRATUM application developed by the USDA Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research.

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Executive Summary

Community trees play a critical role in Los Altos. They provide numerous benefits both tangible and intangible to residents, visitors, and the community at large. With an urban forest of 6,473 individual trees, urban forest managers recognize that community trees are a valued community resource, an important component of city infrastructure, and part of the community identity.

In 2016, to support the preservation and management of community trees, the city commissioned an inventory of trees in parks and in some street medians. The inventory produced a GIS layer that includes vital information about each tree including species, size, condition, and geographic location. Davey Resource Group (DRG) used this 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 these trees as well as their management needs. Los Altos' community urban forest includes 6,473 public trees of 152 unique species across community. DRG determined that the following information characterizes this urban forest resource:

- Broadleaf species make up 87% of the total inventory, compared to nearly 22% conifers. The predominant tree species are coast live oak (*Quercus agrifolia*, 18%), coast redwood (*Sequoia sempervirens*, 15%), and Chinese pistache (*Pistacia chinensis*, 11%).
- 39% of trees are young or small-statured at 8 inches or less in diameter (DBH) and just 15% of trees are larger than 24 inches in diameter, indicating a population with a nearly ideal age distribution.
- 100 acres of tree canopy cover Los Altos parks and inventoried medians.
- To date, community trees have stored 9,060 tons of carbon dioxide (CO_2), valued at $135,899.
- Replacement with trees of similar size, species, and condition would cost nearly $21.5 million.

Benefits

Annually, community trees provide cumulative benefits to the community worth $4.8 million, a value of $741.22 per tree and $158.99 per capita. These annual impacts include:

- Reducing electricity and natural gas use through shading and climate effects for a benefit of $125,060, an average of $19.32 per tree.
- Intercepting 6.7 million gallons of stormwater annually – the equivalent of 10 Olympic swimming pools – valued at $52,070, an average of $8.04 per tree.
- Adding to property value, health, aesthetics, and socioeconomic benefits valued at $4.5 million, an average of $700 per tree.

- Reducing atmospheric carbon dioxide by 732 tons, valued at $10,977, an average of $1.70 per tree.
- Improving air quality by removing a net 1,490 pounds of air pollutants, valued at $14,476, an average of 12.15 per tree.

When the annual investment of $405,000 for the management of the community urban forest is considered, the annual net benefit (benefits minus investment) for the community is nearly $4.4 million, an average of $668. per tree, or 143 per capita. In other words, **for every $1 invested in public trees, the community receives $11.85 in benefits.**

Management

Los Altos' community trees are 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 continue to mature and aging trees are replaced, the overall value of the community forest and the amount of benefits provided grow as well. This vital, living resource is, however, 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.

Based on this resource analysis, DRG recommends the following:

- Increase species diversity by insuring that new tree plantings include a variety of suitable species and don't unduly increase reliance on prevalent species.
- Use all available planting sites to improve diversity and increase benefits. Specifically, install large-stature species wherever space allows.
- Provide structural pruning for young trees and a regular pruning cycle for all trees.
- Protect existing trees, especially mature native species, and manage risk with regular inspection to identify and mitigate structural and age-related defects.
- Continue to maintain and update the inventory database, including tracking tree growth and condition during regular pruning cycles.

Proactive management (including a tree replacement plan) is critical to ensuring that the community continues to receive a high return on their investment. 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 community trees support the quality of life for all community members.

Introduction

Los Altos is a primarily residential community in the heart of the Silicon Valley. The 30,177 residents in 10,745 households enjoy the community's small village atmosphere and tree-lined streets, which characterize the city. A desirable area to live, the median home price is $2.8 million, and the school district boasts 96% of high school graduates continue to college. US News & World Report ranks both high schools in the top 1% nationally.

The primary watershed is Adobe Creek, which flows through Redwood Grove Park, a natural area purchased by the city in 1974. The coast redwoods were transplanted from the Santa Cruz mountains by the Halsey family in the early 1900s. These and other heritage trees are protected by city ordinance that requires a permit for the removal of trees over 48″ DBH, other designated trees, trees preserved in development, and any tree in the public right-of-way.

Individual trees and a healthy urban forest play an important role in the quality of life and the sustainability of the community. Research demonstrates that healthy urban trees can improve the local environment and diminish the impact resulting from urbanization and industry (Center for Urban Forest Research). 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 for city residents.

In addition to these direct improvements, healthy urban trees increase the overall attractiveness of an area and the value of local real estate by 7% to 10%. Trees promote 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). Community trees, soften the urban hardscape by providing a green sanctuary, making the community a more enjoyable place to live, work, and play. The community trees play a prominent role in the overall urban forest benefits afforded to Los Altos. The Los Altos Maintenance Division has the responsibility to maintain park trees. Adjacent property owners maintain an estimated 12,000 street trees throughout the community.

To support the management of the community urban forest, an inventory of park and some street median trees was collected in 2016. The inventory collected the species, size, condition, and geographic location of each tree in an electronic, GIS format. An urban forest is a dynamic resource, constantly changing and growing in response to environment and care. Maintaining and updating this inventory information will be critical for ongoing management.

The tree inventory data was analyzed with i-Tree's *Streets*, a STRATUM Analysis Tool (*Streets* v5.1.5; i-Tree v6.1.15), to develop a resource analysis and report of the existing condition of this urban forest. This report, unique to the Los Altos inventoried tree population, quantifies the value of trees to show actual benefits derived from the tree resource. In addition, the report provides baseline values that can be used to develop and update an urban forest management plan. Management plans help urban foresters determine where to focus available resources and set benchmarks for measuring progress.

This analysis describes the structure, function, and value of Los Altos' community trees. 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 Los Altos' community tree resource and an established benchmark for future management decisions.
- The economic value of the benefits from the urban forest, 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 partner agencies and foundations.
- Benchmark data for developing a long-term urban forest management plan.

Individual trees and a healthy urban forest play an important role in the quality of life and the sustainability of the community.

Los Altos’ Urban Forest Resource

An urban forest is more thoroughly understood through examination of composition and species richness (diversity). Consideration of canopy cover, age distribution, condition, and performance provides a foundation for planning and management strategies. Analysis of 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 are the greatest portion of Los Altos’ community urban forest, comprising over 87% of the total inventory, compared to nearly 22% conifers (Figure 1). Broadleaf evergreen species make up 40% of the tree population, including 26% large-stature, 8% medium-stature, and 6% small-stature trees. Broadleaf deciduous trees comprise 38% of the population, with 9% large-stature, 21% medium-stature, and 8% small-stature. There are 19 inventoried palms, comprising 0.29% of the population.

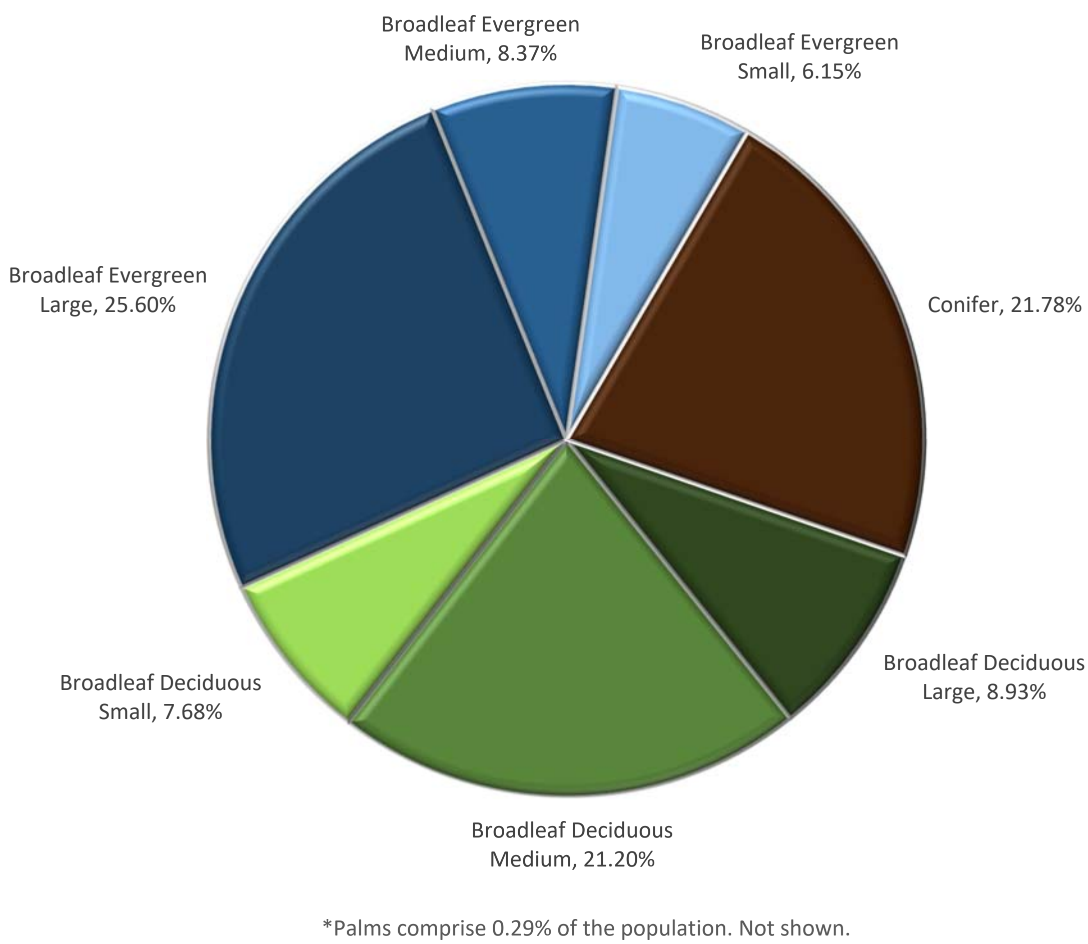


Figure 1. Composition of Tree Type and Stature in Los Altos’ Community Urban Forest

Species Richness and Composition

The tree resource in Los Altos is composed of a wide variety of more than 152 unique species (Table 1 and Appendix C). The top three species at Los Altos represent 43% of the overall population (Figure 2). The most predominant tree species are coast live oak (*Quercus agrifolia*, 17.7%), coast redwood (*Sequoia sempervirens*, 14.5%), and Chinese pistache (*Pistacia chinensis*, 10.9%). There is a widely accepted rule that no single species should represent greater than 10% of the total population, and no single genus more than 20% (Clark Et al, 1997). All three of the most prevalent species exceed this recommendation. Coast live oak and coast redwood are native to the region. The relatively high portion of apricot (*Prunus armeniaca*, 4%) and olive (*Olea europea*, 5%) reflects Los Altos' agrarian heritage. Figure 2 shows tree populations that represent greater than 0.5% of the inventoried trees.

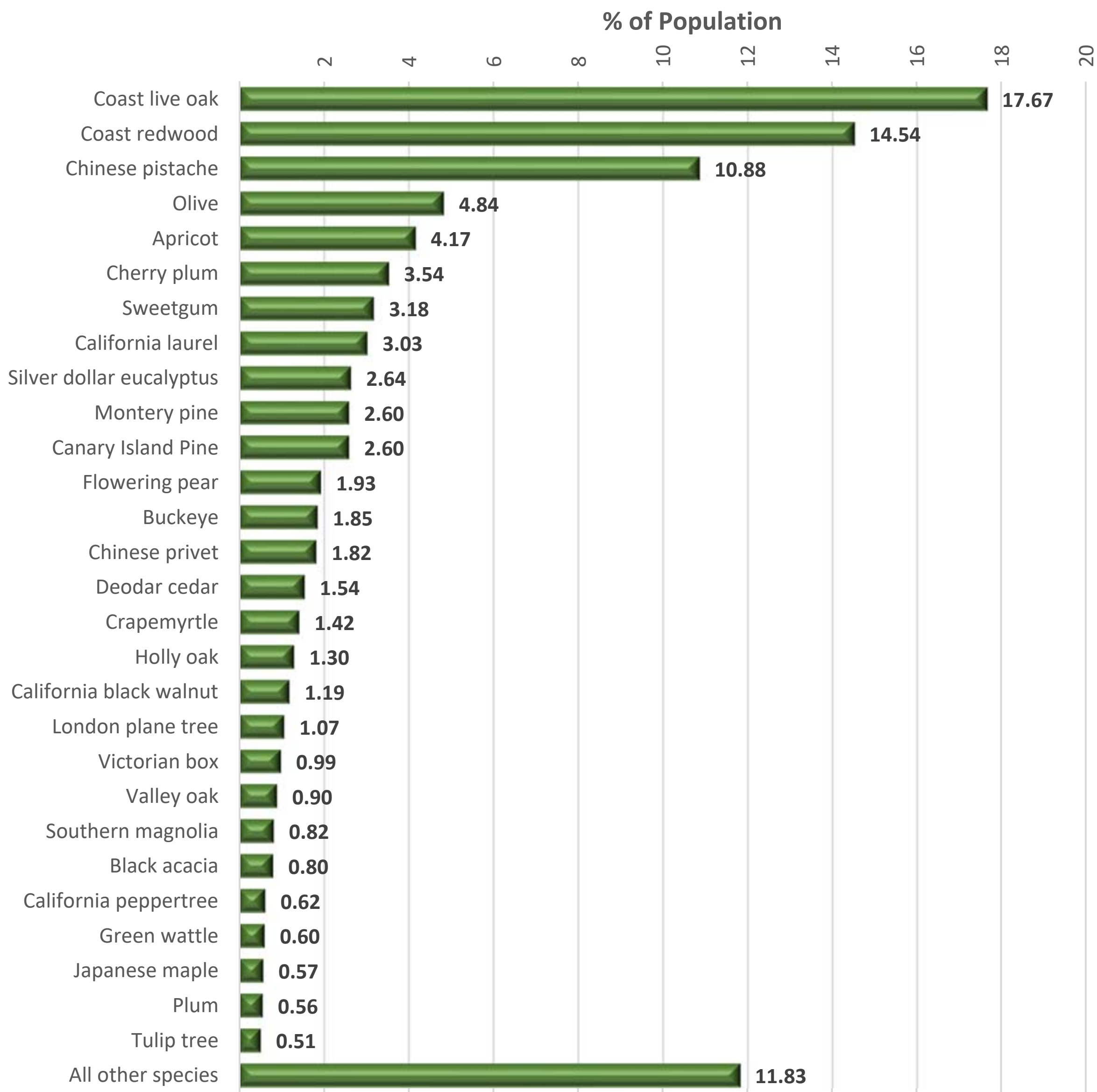


Figure 2. Los Altos' Most Prevalent Species

Maintaining diversity in an urban forest 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 an urban forest and the flow of benefits and costs over time. Catastrophic pathogens, such as Oak Wilt (*Ceratocystis fagacearum*), elm disease (*Ophiostoma ulmi*), emerald ash borer (*Agrilus planipennis*), Asian longhorned beetle (*Anoplophora glabripennis*), and sudden oak death (SOD) (*Phytophthora ramorum* and others) 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.

Table 1. Population Summary of Los Altos' Most Prevalent Species

	DBH Class (in)										
Species	**0-3**	**3-6**	**6-12**	**12-18**	**18-24**	**24-30**	**30-36**	**36-42**	**> 42**	**Total**	**% of Pop.**
Broadleaf Deciduous Large (BDL)											
Sweetgum	1	9	119	68	8	1	0	0	0	**206**	**3.18%**
California black walnut	1	7	19	33	11	2	3	1	0	**77**	**1.19%**
London plane tree	6	9	34	9	7	2	2	0	0	**69**	**1.07%**
Valley oak	1	7	28	11	2	4	2	2	1	**58**	**0.90%**
Tulip tree	0	1	9	14	6	3	0	0	0	**33**	**0.51%**
Other BDL	20	35	42	16	15	1	3	0	3	**135**	**2.09%**
BDL Total	**29**	**68**	**251**	**151**	**49**	**13**	**10**	**3**	**4**	**578**	**8.93%**
Broadleaf Deciduous Medium (BDM)											
Chinese pistache	45	94	314	229	20	2	0	0	0	**704**	**10.88%**
Apricot	48	79	116	26	0	0	0	0	1	**270**	**4.17%**
Flowering pear	10	20	74	21	0	0	0	0	0	**125**	**1.93%**
Buckeye	48	32	32	6	2	0	0	0	0	**120**	**1.85%**
Other BDM	25	29	48	30	13	7	1	0	0	**153**	**2.36%**
BDM Total	**176**	**254**	**584**	**312**	**35**	**9**	**1**	**0**	**1**	**1,372**	**21.20%**
Broadleaf Deciduous Small (BDS)											
Cherry plum	52	123	51	3	0	0	0	0	0	**229**	**3.54%**
Crapemyrtle	54	28	9	1	0	0	0	0	0	**92**	**1.42%**
Japanese maple	7	19	11	0	0	0	0	0	0	**37**	**0.57%**
Plum	11	18	6	1	0	0	0	0	0	**36**	**0.56%**
Other BDS	31	41	27	4	0	0	0	0	0	**103**	**1.59%**
BDS Total	**155**	**229**	**104**	**9**	**0**	**0**	**0**	**0**	**0**	**497**	**7.68%**
Broadleaf Evergreen Large (BEL)											
Coast live oak	48	234	379	224	147	59	30	10	13	**1,144**	**17.67%**
California laurel	79	54	41	13	3	1	1	1	3	**196**	**3.03%**
Silver dollar eucalyptus	0	5	18	52	49	38	8	1	0	**171**	**2.64%**
Holly oak	0	20	21	24	17	2	0	0	0	**84**	**1.30%**
Other BEL	8	8	9	5	12	11	2	2	5	**62**	**0.96%**
BEL Total	**135**	**321**	**468**	**318**	**228**	**111**	**41**	**14**	**21**	**1,657**	**25.60%**

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total	% of Pop.
Broadleaf Evergreen Medium (BEM)											
Olive	13	15	226	43	12	3	1	0	0	**313**	**4.84%**
Southern magnolia	6	1	16	26	3	1	0	0	0	**53**	**0.82%**
Black acacia	1	12	25	6	3	4	0	1	0	**52**	**0.80%**
California peppertree	0	2	5	8	9	8	3	1	4	**40**	**0.62%**
Other BEM	10	21	26	12	7	7	1	0	0	**84**	**1.30%**
BEM Total	**30**	**51**	**298**	**95**	**34**	**23**	**5**	**2**	**4**	**542**	**8.37%**
Broadleaf Evergreen Small (BES)											
Chinese privet	24	41	46	7	0	0	0	0	0	**118**	**1.82%**
Victorian box	3	36	24	1	0	0	0	0	0	**64**	**0.99%**
Green wattle	1	4	17	12	3	2	0	0	0	**39**	**0.60%**
Other BES	69	71	33	4	0	0	0	0	0	**177**	**2.73%**
BES Total	**97**	**152**	**120**	**24**	**3**	**2**	**0**	**0**	**0**	**398**	**6.15%**
Conifer											
Coast redwood	27	40	74	129	182	180	153	82	74	**941**	**14.54%**
Canary Island pine	2	9	13	48	67	22	6	1	0	**168**	**2.60%**
Monterey pine	3	1	5	22	46	53	28	5	5	**168**	**2.60%**
Deodar cedar	5	6	19	22	25	10	8	3	2	**100**	**1.54%**
Other Conifers	3	5	3	6	7	3	3	1	2	**33**	**0.51%**
Conifer Total	**40**	**61**	**114**	**227**	**327**	**268**	**198**	**92**	**83**	**1,410**	**21.78%**
Palm											
Other palms	0	0	1	0	4	8	5	1	0	**19**	**0.29%**
Palm Total	**0**	**0**	**1**	**0**	**4**	**8**	**5**	**1**	**0**	**19**	**0.29%**
Grand Total	**662**	**1,136**	**1,940**	**1,136**	**680**	**434**	**260**	**112**	**113**	**6,473**	**100%**

Species Importance

To quantify the significance of any one species in Los Altos' community tree inventory, an importance value is derived for each of the most common species. Importance values are particularly meaningful to urban forest managers because they indicate a reliance on the functional capacity of a particular 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).

No single species should dominate the composition of an urban forest population. Since the 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 most abundant species, the risk of major reductions to benefits is significantly reduced. Of course, suitability of the dominant species is another important consideration. Planting short-lived or poorly adapted species can result in shorter lifespans and increased long-term management investments.

The most abundant species, each representing greater than 0.5% of the population, are listed in Table 2. These 28 species represent 88% of the overall population, 92% of the total leaf area, and 91% of the total canopy cover for a combined importance value of 90.5 (Table 2). Of these, Los Altos relies most on two native species: coast redwood (*Sequoia sempervirens*, IV=22.96) and coast live oak (*Quercus agrifolia*, IV=17.36). These species dominate the inventory, providing significant benefits and sense of place. These should be carefully maintained as to not lose the character they give the community and to maintain their contribution to the community urban forest.

Due to their large stature and high leaf surface area, some species provide more impact than their population numbers alone would suggest. For example, coast redwood (*Sequoia sempervirens*) represents 14.5% of the population but nearly 27% of canopy cover, and 27% of leaf surface area. These are large-stature trees and the population includes a large portion (85%) of established trees (over 12" DBH).

The low importance value of some species is a function of tree type. Immature and small-stature populations tend to have lower importance values than their percentage in the overall population might suggest. This is due to their relatively small leaf area and canopy coverage. For instance, cherry plum (*Prunus ceracifera*) represent 3.5% of the population but the importance value of the species is 1.59 because the crowns contribute just 0.54% of the total leaf area and 0.69% of the canopy.

Table 2. Importance Value of Los Altos' Most Prevalent Species

Species	Number of Trees	% of Pop.	Leaf Area (ft²)	% of Total Leaf Area	Canopy Cover (ft²)	% of Total Canopy Cover	Importance Value
Coast live oak	1,144	17.67	2,594,071	17.41	741,944	16.98	17.36
Coast redwood	941	14.54	4,081,531	27.40	1,176,791	26.94	22.96
Chinese pistache	704	10.88	1,544,744	10.37	541,972	12.41	11.22
Olive	313	4.84	341,839	2.29	138,290	3.17	3.43
Apricot	270	4.17	249,443	1.67	87,815	2.01	2.62
Cherry plum	229	3.54	81,029	0.54	30,238	0.69	1.59
Sweetgum	206	3.18	418,869	2.81	86,086	1.97	2.65
California laurel	196	3.03	171,679	1.15	46,177	1.06	1.75
Silver dollar eucalyptus	171	2.64	729,444	4.90	200,752	4.60	4.04
Monterey pine	168	2.60	734,518	4.93	201,220	4.61	4.04
Canary Island pine	168	2.60	544,752	3.66	133,631	3.06	3.10
Flowering pear	125	1.93	147,868	0.99	54,224	1.24	1.39
Buckeye	120	1.85	83,661	0.56	27,533	0.63	1.02
Chinese privet	118	1.82	95,165	0.64	33,032	0.76	1.07
Deodar cedar	100	1.54	311,919	2.09	81,170	1.86	1.83
Crapemyrtle	92	1.42	19,167	0.13	7,347	0.17	0.57
Holly oak	84	1.30	148,400	1.00	52,651	1.21	1.17
California black walnut	77	1.19	283,575	1.90	82,565	1.89	1.66
London plane tree	69	1.07	135,590	0.91	48,851	1.12	1.03
Victorian box	64	0.99	50,500	0.34	16,840	0.39	0.57
Valley oak	58	0.90	156,809	1.05	40,203	0.92	0.96
Southern magnolia	53	0.82	73,207	0.49	24,123	0.55	0.62
Black acacia	52	0.80	116,199	0.78	27,743	0.64	0.74
California peppertree	40	0.62	361,943	2.43	51,147	1.17	1.41
Green wattle	39	0.60	65,108	0.44	24,797	0.57	0.54
Japanese maple	37	0.57	26,679	0.18	10,905	0.25	0.33
Plum	36	0.56	11,304	0.08	4,275	0.10	0.24
Tulip tree	33	0.51	118,906	0.80	20,985	0.48	0.60
All other species	766	11.83	1,199,973	8.05	375,333	8.59	9.49
Total	**6,473**	**100%**	**14,897,895**	**100%**	**4,368,640**	**100%**	**100.00**

Canopy Cover and Leaf Area

The amount and distribution of leaf surface area is the driving force behind the urban forest's ability to produce benefits for the community (Clark, 1997). As canopy cover increases, so do the benefits afforded by leaf area. Los Altos encompasses an area of 6.487 square miles. Overall, community trees provide approximately 4.3 million square feet (100 acres) of canopy cover. This value, which is calculated for inventoried trees only, accounts for 2.4% of Los Altos' land area. The coast redwood (*Sequoia sempervirens*) population provides the greatest canopy, at 1.1 million square feet (27 acres). This analysis only considers inventoried community trees, and it is important to recognize that the city's canopy cover includes canopy cover from both public and private trees. A deeper understanding of community canopy distribution can be attained through an urban tree canopy assessment, which relies on geospatial analysis of aerial imagery.

Stored Carbon Dioxide

Over their entire lives, the inventoried trees have stored a total of 9,060 tons of carbon in woody biomass, valued at $135,899. Trees store carbon in their tissues as lignin, sugars, and starches. As trees grow and increase their woody material they increase woody biomass annually. Foliage also sequesters carbon dioxide, but foliar biomass cycles more quickly as trees drop leaves and grow new ones.

Relative Age Distribution

Age distribution can be approximated by considering the DBH range of the overall population 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 diameters (DBH) less than eight inches, while only 10% should be in the large diameter classes (>24 inches DBH).

The age distribution of Los Altos' community urban forest is nearly ideal, with 39.2% of trees 8 inches or less in diameter (DBH) and 17.8% of trees larger than 24 inches in diameter (Figure 3). These larger trees are in important part of the community heritage, which include many historic oaks and redwoods. These mature trees require routine maintenance and regular inspection as they age. Tree Risk Assessments can be a valuable tool to help managers understand the specific risks associated with these larger stature trees. The community has a fairly large population (1,940 trees, 22%) of established trees (6" to 12" inch DBH). With regular inspection and proactive management, these trees have a high potential to increase in the benefits they provide over time as they continue to grow and establish.

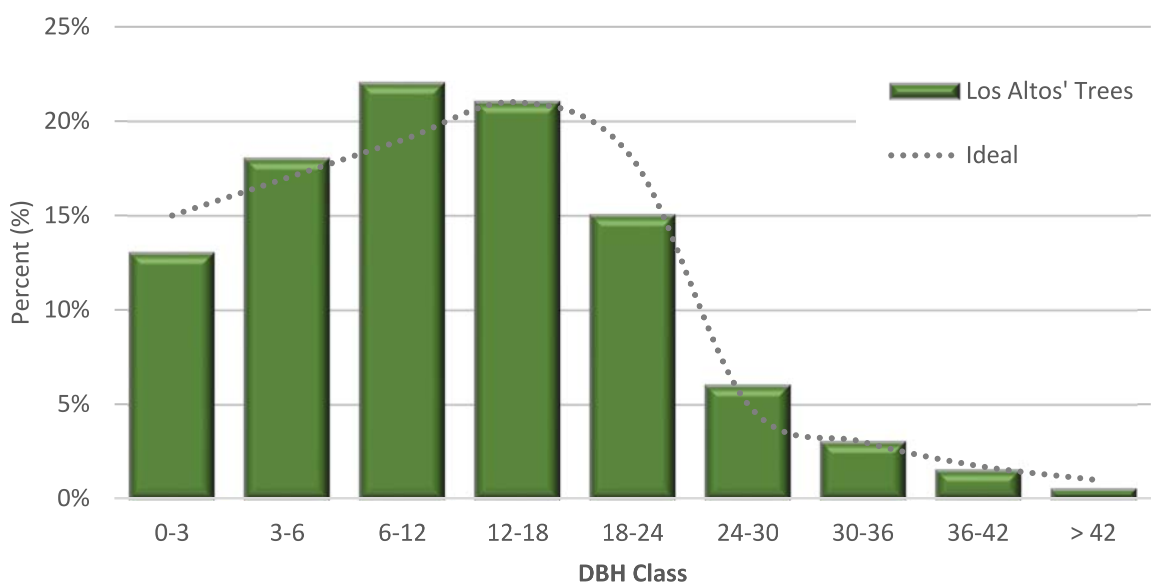


Figure 3. Age Distribution of Los Altos' Community Urban Forest

Relative age distribution can also be considered by individual species' populations. Among the eleven most common species in Los Altos' community urban forest, the most petite population is cherry plum (*Prunus ceracifera*) (Figure 4). Over 76% of these trees are 6 inches or less in diameter. Because cherry plum is a small tree at maturity, a small average DBH is expected. In comparison, a tree with a medium stature at maturity, Chinese pistache (*Pistacia chinensis*) shows young, establishing population. This suggests that recent tree plantings have increased the prevalence of this species. Among these four species, annual benefits can be expected to remain stable for olive (*Olea europea*), apricot (*Prunus amygdalus*), and cherry plum (*Prunus ceracifera*), but benefits from Chinese pistache (*Pistacia chinensis*) can be expected to increase as the population reaches mature stature. In contrast, the DBH distributions of silver dollar eucalyptus (*Eucalyptus polyanthemos*), Canary Island pine (*Pinus canarienses*), and sweetgum (*Liquidambar styraciflua*) show large-stature trees which have not been emphasized in recent planting palettes.

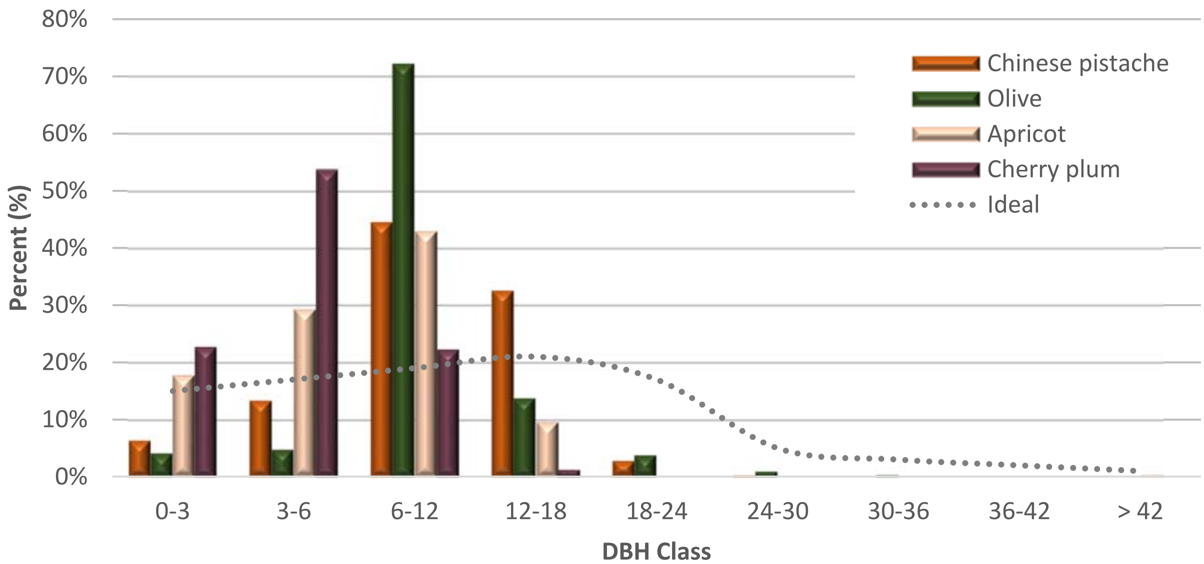


Figure 4. Relative Age Distribution of Chinese Pistache, Olive, Apricot, and Cherry Plum

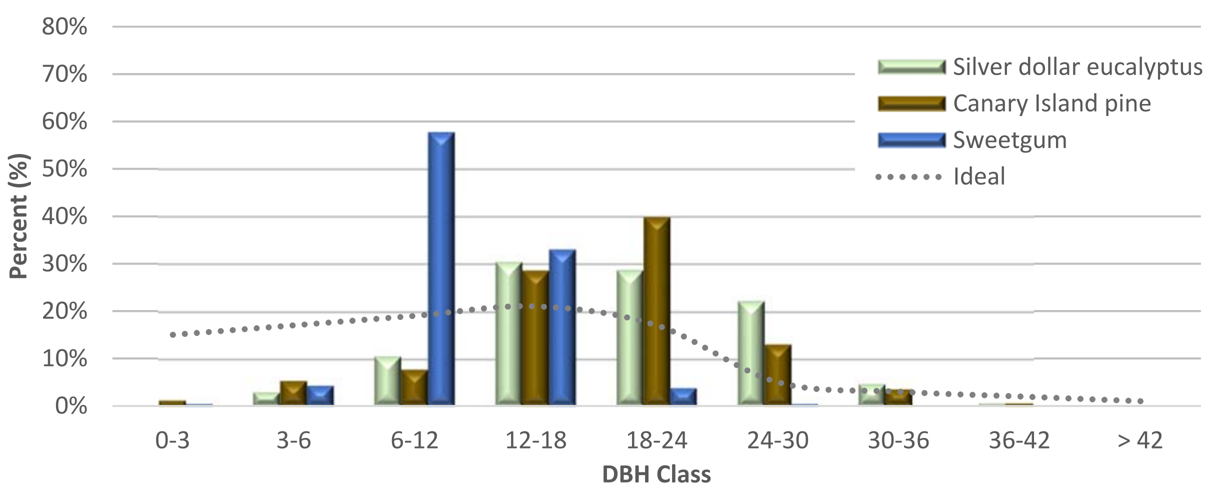


Figure 5. Relative Age Distribution of Large-Stature Prevalent Species

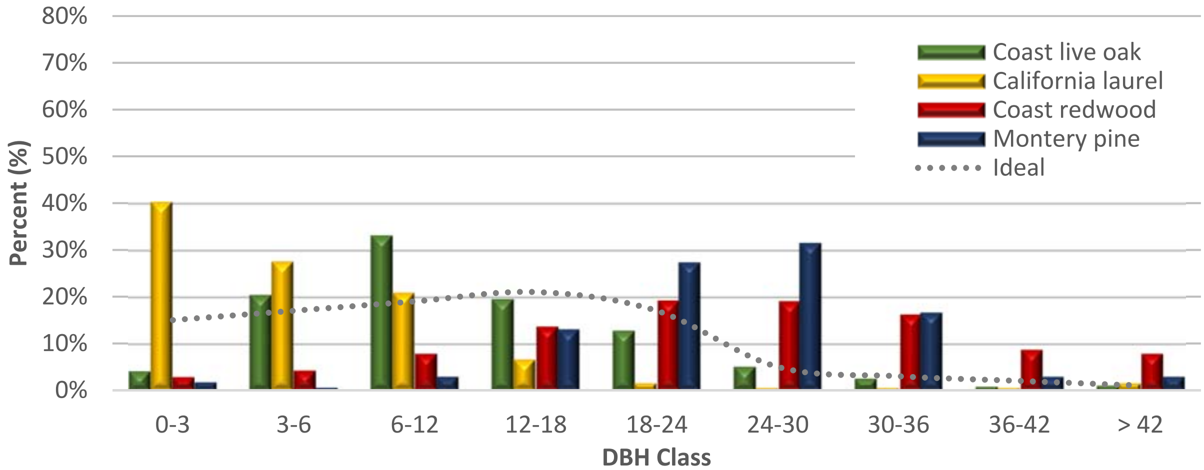


Figure 6. Relative Age Distribution of Most Prevalent Native Species

The four most common native species show contrasting patterns of DBH distribution. The DBH distribution of coast live oak (*Quercus agrifolia*) is nearly ideal. The population of California laurel (*Umbellularia calfiornica*) shows a young, establishing population. Two native conifers, coast redwood (*Sequoia sempervirens*), and Monterey pine (*Pinus radiata*) are established populations with fewer young individuals.

In conclusion, understanding these prevalent species' age distributions can help urban forest managers anticipate maintenance activities and budgetary needs. It can also help managers identify trends in recent planting palettes and inform future plant purchases and strategies. Furthermore, these distributions can help urban forest managers anticipate expected changes in benefit streams. Los Altos has a large population (1,940 trees, 22%) of petite, or young, establishing trees (6" to 12" inch DBH), and 39% of the population is under 8" DBH. While several species will provide a stable benefit stream (olive, cherry plum, apricot), benefits from coast live oak, California laurel, and Chinese pistache (*Pistacia chinensis*) will likely rise with the growth of these medium to large-stature species. With regular inspection and management, these trees have a high potential to increase in the benefits they provide over time as they continue to grow and establish.

Urban Forest Condition

Tree condition is an indication of tree management quality and how well trees are performing in their site-specific environment (e.g., median, park, etc.). Condition ratings can help urban forest managers anticipate maintenance and funding needs. In addition, tree condition is an important factor for the calculation of urban forest 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.

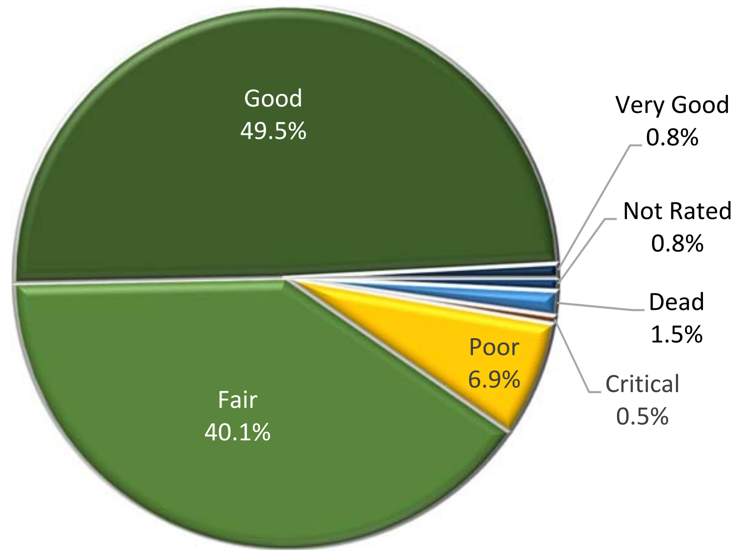


Figure 7. Tree Condition

Los Altos' community forest is overall relatively young and in fair to good condition with 50% good and 40% fair trees (Figure 5). About 10% of Los Altos' community trees are in poor condition, declining, or dead.

Relative Performance Index

The *relative performance index* (RPI) is one way to further analyze the condition and suitability of 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 population. An RPI of 1.0 or better indicates that the species is performing as well or better than average. An RPI value below 1.0 indicates that the species is not performing as well in comparison to the rest of the population.

Among the 28 most common species inventoried (each population representing more than 0.5%), thirteen (13) have an RPI of 1.0 or greater (Table 3). Of these, London plane tree (*Platanus x hispanica*, RPI=1.15), Crapemyrtle (*Lagerstroemia indica*, RPI=1.10), and California laurel (*Umbellularia californica*, RPI 1.03) have the highest RPIs, while plum (*Prunus* spp., RPI=0.80), and California black walnut (*Juglans hindsii*, RPI=0.77) have the lowest.

The RPI can be a useful tool for urban forest managers. For example, if a community has been planting two or more new species, the RPI can be used to compare their relative performance. If the RPI indicates that one is performing relatively poorly, managers may decide to reduce or even stop planting that species and subsequently save money on both planting stock and replacement costs. The RPI enables managers to look at the performance of long-standing species as well. Established species with an RPI of 1.00 or greater have performed well when compared to the population as a whole. These top performers should be retained, and planted, as a healthy proportion of the overall population. It is important to keep in mind that, because RPI is based on condition at the time of the inventory, it may not reflect cosmetic or nuisance issues, especially seasonal issues that are not threatening the health or structure of the trees.

An RPI value less than 1.00 may be indicative of a species that is not well adapted to local conditions. Poorly adapted species are more likely to present increased safety and maintenance issues. Species with an RPI less than 1.00 should receive careful consideration before being selected for future planting choices. However, prior to selecting or deselecting trees based on RPI alone, managers should consider the age distribution of the species, among other factors. A species that has an RPI of less than 1.00, but has a significant number of trees in larger DBH classes, may simply be exhibiting signs of population senescence. A complete table, with RPI values for all species, is included in Appendix C.

Table 3. Relative Performance Index of Most Prevalent Species

Species	Percent of Trees in Condition (%)							RPI	# of Trees	% of Pop.
	Very Good	Good	Fair	Poor	Critical	Dead or Dying	N/A			
Coast live oak	0.61	57.60	36.19	3.85	0.35	0.52	0.87	**1.05**	1,144	17.67
Coast redwood	1.06	41.02	42.61	10.84	2.13	1.70	0.64	**0.95**	941	14.54
Chinese pistache	1.42	62.07	33.52	2.41	0.14	0.14	0.28	**1.08**	704	10.88
Olive	0.00	17.57	75.40	6.39	0.00	0.00	0.64	**0.90**	313	4.84
Apricot	0.00	60.00	31.85	7.41	0.00	0.74	0.00	**1.05**	270	4.17
Cherry plum	0.87	63.32	23.14	7.42	0.44	4.37	0.44	**1.03**	229	3.54
Sweetgum	0.97	48.06	44.66	4.37	0.00	0.49	1.46	**1.01**	206	3.18
California laurel	0.51	72.96	20.41	5.10	0.00	0.00	1.02	**1.10**	196	3.03
Silver dollar eucalyptus	0.00	35.09	58.48	5.26	0.00	0.58	0.58	**0.96**	171	2.64
Monterey pine	0.00	29.17	55.95	9.52	0.60	4.17	0.60	**0.90**	168	2.60
Canary Island pine	1.19	66.07	26.19	4.17	0.60	1.19	0.60	**1.08**	168	2.60
Flowering pear	0.00	31.20	60.80	4.80	0.00	0.80	2.40	**0.93**	125	1.93
Buckeye	0.00	66.67	28.33	3.33	0.00	0.83	0.83	**1.08**	120	1.85
Chinese privet	0.00	40.68	43.22	11.02	0.85	4.24	0.00	**0.94**	118	1.82
Deodar cedar	8.00	48.00	32.00	11.00	0.00	0.00	1.00	**1.02**	100	1.54
Crapemyrtle	2.17	67.39	28.26	1.09	0.00	0.00	1.09	**1.10**	92	1.42
Holly oak	0.00	53.57	39.29	7.14	0.00	0.00	0.00	**1.03**	84	1.30
California black walnut	0.00	6.49	63.64	25.97	1.30	2.60	0.00	**0.77**	77	1.19
London plane tree	0.00	82.61	15.94	0.00	0.00	0.00	1.45	**1.15**	69	1.07
Victorian box	0.00	23.44	64.06	12.50	0.00	0.00	0.00	**0.90**	64	0.99
Valley oak	0.00	48.28	43.10	6.90	0.00	0.00	1.72	**1.00**	58	0.90
Southern magnolia	0.00	32.08	60.38	7.55	0.00	0.00	0.00	**0.95**	53	0.82
Black acacia	0.00	32.69	57.69	5.77	0.00	1.92	1.92	**0.93**	52	0.80
California peppertree	0.00	45.00	52.50	0.00	0.00	2.50	0.00	**1.01**	40	0.62
Green wattle	0.00	25.64	51.28	12.82	0.00	10.26	0.00	**0.84**	39	0.60
Japanese maple	0.00	40.54	54.05	5.41	0.00	0.00	0.00	**0.99**	37	0.57
Plum	0.00	41.67	19.44	16.67	2.78	19.44	0.00	**0.80**	36	0.56
Tulip tree	0.00	36.36	45.45	15.15	0.00	0.00	3.03	**0.92**	33	0.51
All other species	1.31	44.26	38.64	10.57	0.13	3.66	1.44	**0.95**	766	11.83
Citywide Average	**0.83**	**49.07**	**40.40**	**6.95**	**0.49**	**1.48**	**0.77**	**1.00**	**6,473**	**100%**

The RPI value can also help to identify underused species that are demonstrating good performance. Trees with an RPI value greater than 1.00 and an established age distribution may be indicating their suitability in the local environment and should receive consideration for additional planting (Table 4). When considering new species based on RPI, it is important to base the decision on established populations. The greater number of trees of a particular species, the more relevant the RPI becomes.

Table 4: Species That May Be Underused (based on RPI)

Species	RPI	# of Trees	% of Pop.
London plane tree	**1.15**	69	1.07
Crapemyrtle	**1.10**	92	1.42
Buckeye	**1.08**	120	1.85
Canary Island pine	**1.08**	168	2.60
Holly oak	**1.03**	84	1.30
Deodar cedar	**1.02**	100	1.54

Replacement Value

The current value of the community urban forest at Los Altos is over $21.5 million (Table 5). 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, placement, and condition. There are several methods available for obtaining a fair and reasonable perception of a tree's value (CTLA, 1992; Watson, 2002). The cost approach, trunk formula method used in this analysis assumes the value of a tree is equal to the cost of replacing the tree in its current state (Cullen, 2002).

The average replacement value per tree is $3,320. The population of coast redwood (*Sequoia sempervirens*) has the greatest value, at $5.97 million, an average of $6,347 per tree. The three most common species, coast redwood, coast live oak (*Quercus agrifolia*), and Chinese pistache (*Pistacia chinensis*) combined are valued at $12.9 million, about 60% of the inventoried trees' replacement value, while these species represent 43% of the population. On a per-tree basis, silver dollar eucalyptus (*Eucalyptus polyanthemos*, $8,970/tree) and valley oak (*Quercus lobata*, $7,161/tree) have relatively high average values.

Los Altos' trees represent a vital component of the community infrastructure and an asset valued at over $21.5 million—an asset that, with proper care and maintenance, will continue to increase in value over time. It is important to distinguish the replacement value from the value of annual benefits produced by this urban forest resource.

Table 5: Replacement Value for Los Altos' Most Prevalent Species

Species	Replacement Value ($) by DBH Class (in)									Total	% of Replacement Value	% of Pop.
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42			
Coast live oak	6,600	97,911	538,823	852,177	1,093,823	750,501	505,043	214,740	286,209	4,345,827	20.22	17.67
Coast redwood	3,602	12,027	64,826	300,150	743,271	1,145,675	1,433,698	1,141,248	1,128,465	5,972,962	27.79	14.54
Chinese pistache	7,443	65,963	760,104	1,479,826	249,921	40,487	0	0	0	2,603,743	12.11	10.88
Olive	1,799	5,738	274,720	133,533	72,379	29,756	14,430	0	0	532,354	2.48	4.84
Apricot	8,633	48,035	201,760	104,812	0	0	0	0	28,107	391,347	1.82	4.17
Cherry plum	7,989	46,243	37,121	2,758	0	0	0	0	0	94,111	0.44	3.54
Sweetgum	195	3,922	158,916	234,457	52,840	9,372	0	0	0	459,701	2.14	3.18
California laurel	14,310	31,595	77,020	65,209	17,202	18,505	19,009	35,627	72,610	351,087	1.63	3.03
Silver dollar eucalyptus	0	2,273	26,356	231,816	414,246	616,119	207,513	35,627	0	1,533,950	7.14	2.64
Monterey pine	539	230	1,273	8,800	31,505	57,189	39,957	9,135	10,133	158,760	0.74	2.60
Canary Island pine	296	2,859	8,473	80,720	235,424	134,419	52,422	8,555	0	523,168	2.43	2.60
Flowering pear	1,600	8,849	88,622	64,797	0	0	0	0	0	163,868	0.76	1.93
Buckeye	9,027	11,233	26,795	13,331	6,971	0	0	0	0	67,357	0.31	1.85
Chinese privet	4,507	7,187	11,824	3,723	0	0	0	0	0	27,241	0.13	1.82
Deodar cedar	855	2,481	20,983	53,216	145,641	93,605	118,182	57,034	33,248	525,246	2.44	1.54
Crapemyrtle	9,360	18,376	16,843	6,229	0	0	0	0	0	50,808	0.24	1.42
Holly oak	0	11,743	37,998	105,154	171,357	31,568	0	0	0	357,821	1.66	1.30
California black walnut	167	2,276	14,011	72,251	46,054	15,493	29,076	14,878	0	194,208	0.90	1.19

Species	Replacement Value ($) by DBH Class (in)									Total	% of Replacement Value	% of Pop.
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42			
London plane tree	1,002	3,529	43,922	27,882	40,937	21,949	27,201	0	0	166,422	0.77	1.07
Victorian box	414	17,132	44,915	4,397	0	0	0	0	0	66,858	0.31	0.99
Valley oak	186	4,027	60,306	72,728	20,333	87,955	69,129	64,585	36,096	415,345	1.93	0.90
Southern magnolia	1,002	435	16,687	65,906	12,202	10,974	0	0	0	107,208	0.50	0.82
Black acacia	134	6,402	42,041	24,581	20,510	52,250	0	25,149	0	171,068	0.80	0.80
California peppertree	0	630	4,178	17,360	35,008	49,244	27,610	15,114	57,593	206,736	0.96	0.62
Green wattle	139	2,023	19,646	35,535	15,843	15,939	0	0	0	89,125	0.41	0.60
Japanese maple	1,193	10,996	25,283	0	0	0	0	0	0	37,472	0.17	0.57
Plum	1,578	7,874	8,764	6,229	0	0	0	0	0	24,445	0.11	0.56
Tulip tree	0	179	9,288	37,456	32,277	18,767	0	0	0	97,967	0.46	0.51
All other species	28,240	97,304	243,294	229,457	297,966	354,916	142,539	79,675	283,074	1,756,466	8.17	11.83
Citywide Total	**$110,813**	**$529,469**	**$2,884,792**	**$4,334,490**	**$3,755,711**	**$3,554,684**	**$2,685,809**	**$1,701,370**	**$1,935,534**	**$21,492,672**	**100%**	**100%**

Community Tree Benefits

Community trees are important to Los Altos. Environmentally, they help conserve and reduce energy use, reduce global 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 benefits back to the community. However, the question remains, are the collective benefits worth the cost of management? In other words, are these trees a good investment for Los Altos? To answer this question, the benefits must be quantified in financial terms.

The i-Tree *Streets* analysis model allows benefits to be quantified based on regional reference cities and local community 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 Los Altos' 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 current inventory data for Los Altos' trees and 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. 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 A.

Trees help conserve and reduce energy use, reduce global carbon dioxide (CO_2) levels, improve air quality, and mitigate stormwater runoff.

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 and 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 citywide 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 Los Altos from both the shading and climate effects of trees is equal to 792 MWh (valued at $123,468) and 1,321 therms ($1,592), for a total retail savings of $125,060 and an average of $19.32 per tree (Table 6). The species that contribute most to energy benefits on a per-tree basis are large-stature evergreens including coast redwood, (*Sequoia sempervirens*), with an average annual energy benefit of $35.35 and Monterey pine (*Pinus radiata*) with an average annual energy benefit of $35.19 per tree (Figure 6).

Small-canopy trees are less able to provide electricity and natural gas reduction benefits. On a per-tree basis, plum (Prunus spp.) provides $1.89 in average energy benefits and it is providing just 0.08% of the energy benefits. This is a small-statured tree with little impact on building microclimates.

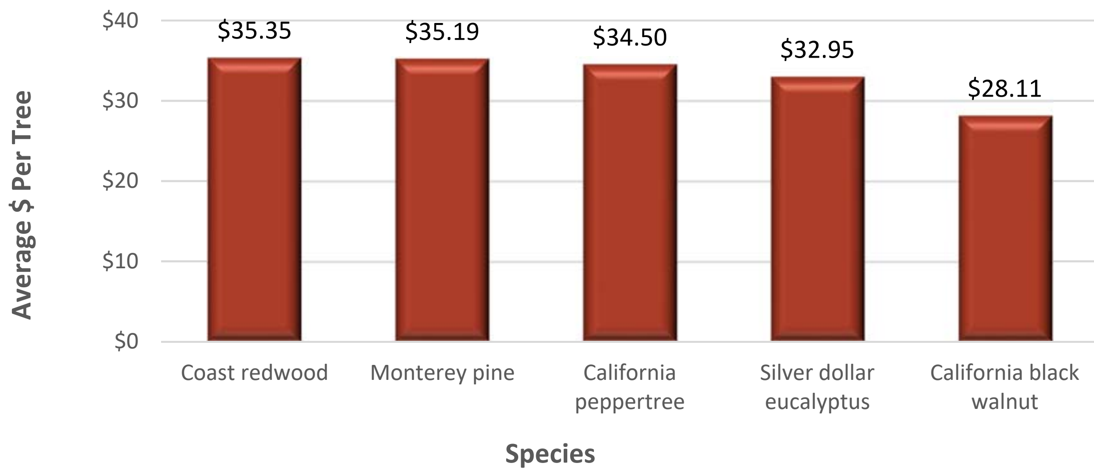


Figure 8. Annual Per-Tree Electricity and Natural Gas Benefits of Top Performers

Reduction of wind speed and the movement of outside air into interior spaces and conductive heat loss where thermal conductivity is relatively high (e.g., glass windows) (Simpson, 1998).

Table 6. Annual Electric and Natural Gas Benefits of Most Prevalent Species

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	% of Pop.	% of Total $	Avg. $/tree
Coast live oak	136.08	21,215	-434.93	-524.09	20,691	17.67	16.54	**18.09**
Coast redwood	202.04	31,498	1461.73	1761.38	33,260	14.54	26.60	**35.35**
Chinese pistache	101.23	15,782	-224.68	-270.74	15,511	10.88	12.40	**22.03**
Olive	27.47	4,282	-143.66	-173.11	4,109	4.84	3.29	**13.13**
Apricot	16.63	2,593	146.70	176.78	2,770	4.17	2.21	**10.26**
Cherry plum	4.61	718	12.76	15.38	734	3.54	0.59	**3.20**
Sweetgum	20.12	3,137	-134.60	-162.19	2,974	3.18	2.38	**14.44**
California laurel	8.21	1,279	-25.78	-31.06	1,248	3.03	1.00	**6.37**
Silver dollar eucalyptus	36.75	5,730	-78.64	-94.76	5,635	2.64	4.51	**32.95**
Monterey pine	35.85	5,589	268.60	323.67	5,913	2.60	4.73	**35.19**
Canary Island pine	26.13	4,074	107.38	129.39	4,203	2.60	3.36	**25.02**
Flowering pear	10.28	1,602	92.53	111.50	1,714	1.93	1.37	**13.71**
Buckeye	5.15	803	45.50	54.82	858	1.85	0.69	**7.15**
Chinese privet	5.91	922	23.41	28.21	950	1.82	0.76	**8.05**
Deodar cedar	15.11	2,355	64.84	78.13	2,433	1.54	1.95	**24.33**
Crapemyrtle	1.07	167	5.22	6.29	174	1.42	0.14	**1.89**
Holly oak	10.02	1,562	-37.35	-45.00	1,517	1.30	1.21	**18.06**
California black walnut	13.67	2,132	27.38	32.99	2,165	1.19	1.73	**28.11**
London plane tree	8.41	1,311	49.92	60.16	1,371	1.07	1.10	**19.87**
Victorian box	3.03	473	8.98	10.82	484	0.99	0.39	**7.56**
Valley oak	7.25	1,130	-24.36	-29.35	1,100	0.90	0.88	**18.97**
Southern magnolia	4.73	737	36.16	43.58	780	0.82	0.62	**14.72**
Black acacia	5.23	816	-21.73	-26.18	790	0.80	0.63	**15.19**
California peppertree	9.00	1,404	-19.53	-23.53	1,380	0.62	1.10	**34.50**
Green wattle	4.39	685	20.59	24.81	710	0.60	0.57	**18.20**
Japanese maple	2.33	363	-19.64	-23.66	340	0.57	0.27	**9.18**
Plum	0.65	101	2.00	2.41	103	0.56	0.08	**2.87**
Tulip tree	4.56	711	-15.76	-18.99	692	0.51	0.55	**20.97**
All other species	66.06	10,298	127.83	154.03	10,452	11.83	8.36	**13.65**
Total	**791.97**	**$123,468**	**1,321**	**$1,592**	**$125,060**	**100%**	**100%**	**$19.32**

Atmospheric Carbon Dioxide Reduction

As environmental awareness continues to increase, governments are paying particular 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 back into space as infrared radiation (heat). Greenhouse gases 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 methane (CH_4), nitrous oxide (N_2O), 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." In the last 150 years, since large-scale industrialization began, the levels of some GHGs, including CO_2, have increased by 25 percent (U.S. Energy Information Administration).

The Center for Urban Forest Research (CUFR) recently led the development of 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 urban forest 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 anywhere in the United States.

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.

Through these processes, community trees reduce CO_2 by 841 tons valued at $12,611.

At the same time, vehicles and other combustion engines used to plant and care for trees release CO_2 during operation. 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 or used to make wood products. These activities release an estimated 5.5 tons of CO_2, valued at $1,634.

Both of these factors must be considered when calculating the cumulative carbon benefits of trees. In Los Altos, the net impact is that trees reduce atmospheric CO_2 by 732 tons, valued at $10,977, with an average value of $1.70 per tree (cumulative) (Table 7).

Monterey pine (*Pinus radiata,* $3.29) and coast redwood (*Sequoia sempervirens,* $3.28) provide the greatest carbon sequestration benefit per tree. The populations of coast live oak (*Quercus agrifolia*), and coast redwood (*Sequoia sempervirens*) combined provide 49% of the carbon benefit value.

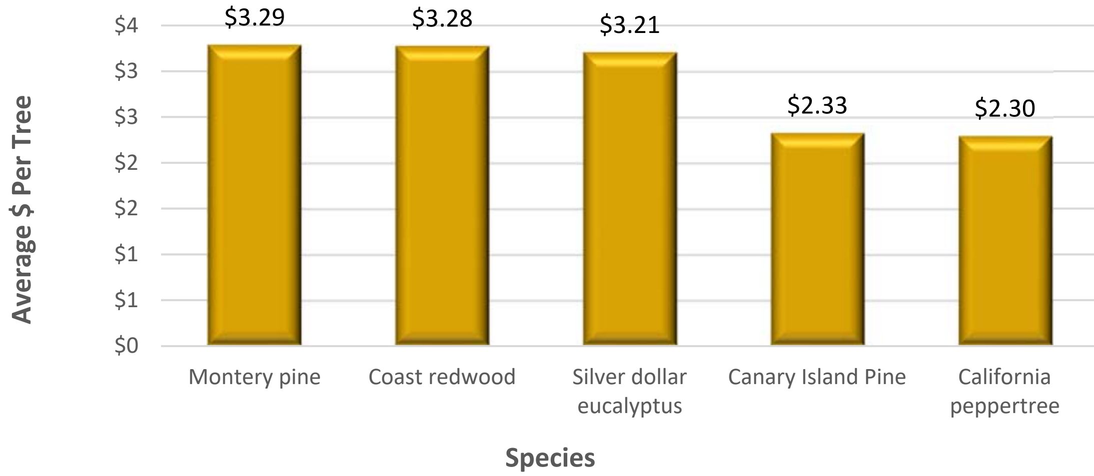
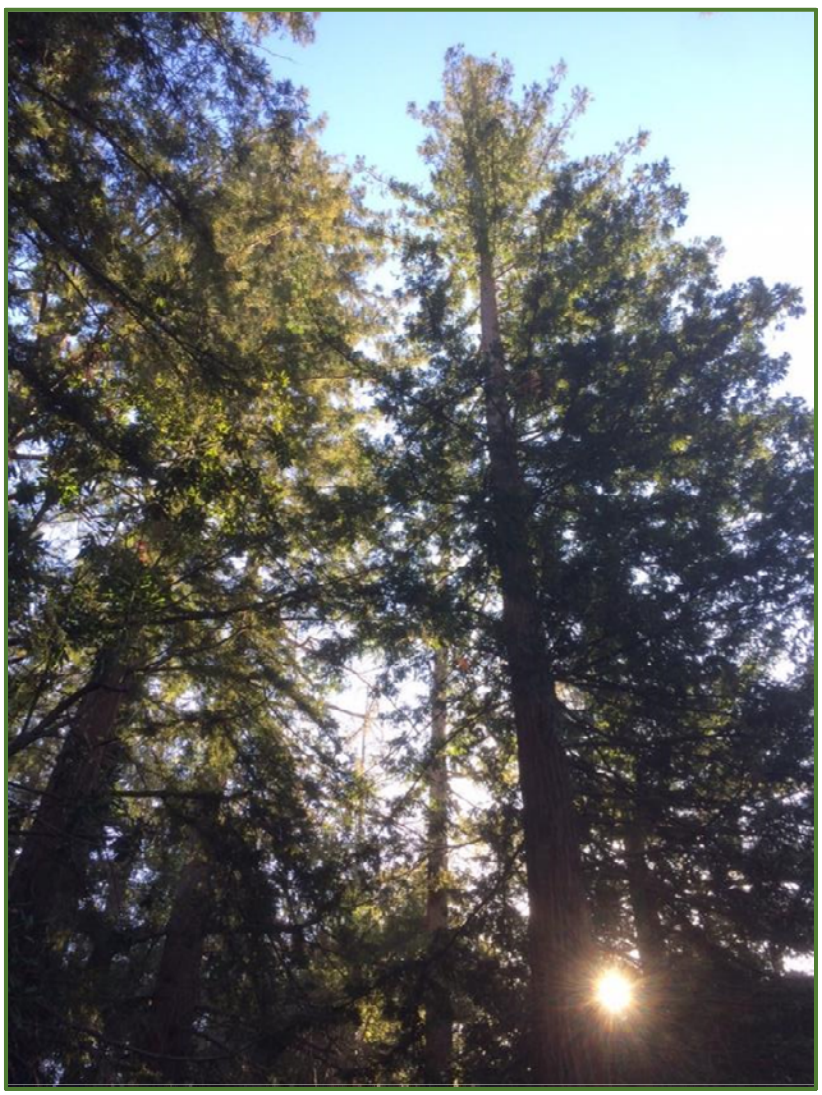


Figure 9. Annual Carbon Benefits of Top Performers



Trees in Los Altos reduce atmospheric CO_2 by 732 tons, valued at $10,977, with an average value of $1.70 per tree.

Table 7. Summary of Annual Carbon Benefits from Most Prevalent Species (lb)

Species	Sequestered (lb)	Decomposition Release (lb)	Maintenance Release (lb)	Avoided (lb)	Net Total (lb)
Coast live oak	239,938	-57,801	-1,890	127,866	**308,112**
Coast redwood	287,486	-62,919	-3,000	189,846	**411,413**
Chinese pistache	29,667	-6,560	-939	95,118	**117,286**
Olive	35,968	-3,912	-407	25,810	**57,459**
Apricot	9,745	-1,152	-246	15,630	**23,977**
Cherry plum	941	-276	-148	4,330	**4,848**
Sweetgum	19,321	-2,268	-303	18,905	**35,654**
California laurel	16,657	-3,155	-159	7,710	**21,054**
Silver dollar eucalyptus	57,050	-17,984	-432	34,535	**73,169**
Monterey pine	50,254	-9,671	-536	33,685	**73,732**
Canary Island Pine	32,837	-4,834	-405	24,555	**52,153**
Flowering pear	5,449	-783	-141	9,656	**14,181**
Buckeye	3,248	-376	-83	4,840	**7,629**
Chinese privet	3,648	-314	-96	5,556	**8,793**
Deodar cedar	19,625	-3,439	-234	14,195	**30,148**
Crapemyrtle	276	-55	-39	1,009	**1,191**
Holly oak	19,108	-3,343	-137	9,413	**25,042**
California black walnut	8,368	-2,086	-146	12,849	**18,984**
London plane tree	4,950	-1,169	-98	7,900	**11,583**
Victorian box	1,866	-137	-52	2,850	**4,527**
Valley oak	11,913	-3,425	-103	6,809	**15,195**
Southern magnolia	2,152	-787	-83	4,440	**5,722**
Black acacia	6,237	-1,205	-75	4,917	**9,874**
California peppertree	7,326	-3,429	-117	8,459	**12,240**
Green wattle	3,296	-447	-61	4,127	**6,915**
Japanese maple	1,911	-69	-25	2,190	**4,006**
Plum	136	-37	-22	608	**685**
Tulip tree	4,466	-800	-65	4,285	**7,885**
All other species	53,460	-14,445	-920	62,070	**100,164**
Citywide Total	**937,298**	**-206,876**	**-10,964**	**744,163**	**1,463,621**

Table 8. Summary of Annual Carbon Benefits from Most Prevalent Species ($)

Species	Sequestered ($)	Decomposition and Maintenance Release ($)	Avoided ($)	Total ($)	% of Pop.	% of Total $	Avg. $/tree
Coast live oak	1,800	-448	959	**2,311**	17.67	21.05	**2.02**
Coast redwood	2,156	-494	1,424	**3,086**	14.54	28.11	**3.28**
Chinese pistache	223	-56	713	**880**	10.88	8.01	**1.25**
Olive	270	-32	194	**431**	4.84	3.93	**1.38**
Apricot	73	-10	117	**180**	4.17	1.64	**0.67**
Cherry plum	7	-3	32	**36**	3.54	0.33	**0.16**
Sweetgum	145	-19	142	**267**	3.18	2.44	**1.30**
California laurel	125	-25	58	**158**	3.03	1.44	**0.81**
Silver dollar eucalyptus	428	-138	259	**549**	2.64	5.00	**3.21**
Monterey pine	377	-77	253	**553**	2.60	5.04	**3.29**
Canary Island pine	246	-39	184	**391**	2.60	3.56	**2.33**
Flowering pear	41	-7	72	**106**	1.93	0.97	**0.85**
Buckeye	24	-3	36	**57**	1.85	0.52	**0.48**
Chinese privet	27	-3	42	**66**	1.82	0.60	**0.56**
Deodar cedar	147	-28	106	**226**	1.54	2.06	**2.26**
Crapemyrtle	2	-1	8	**9**	1.42	0.08	**0.10**
Holly oak	143	-26	71	**188**	1.30	1.71	**2.24**
California black walnut	63	-17	96	**142**	1.19	1.30	**1.85**
London plane tree	37	-10	59	**87**	1.07	0.79	**1.26**
Victorian box	14	-1	21	**34**	0.99	0.31	**0.53**
Valley oak	89	-26	51	**114**	0.90	1.04	**1.96**
Southern magnolia	16	-7	33	**43**	0.82	0.39	**0.81**
Black acacia	47	-10	37	**74**	0.80	0.67	**1.42**
California peppertree	55	-27	63	**92**	0.62	0.84	**2.30**
Green wattle	25	-4	31	**52**	0.60	0.47	**1.33**
Japanese maple	14	-1	16	**30**	0.57	0.27	**0.81**
Plum	1	0	5	**5**	0.56	0.05	**0.14**
Tulip tree	33	-6	32	**59**	0.51	0.54	**1.79**
All other species	401	-115	466	**751**	11.83	6.84	**0.98**
Citywide Total/Average	**$7,030**	**-$1,634**	**$5,581**	**$10,977**	**100%**	**100%**	**$1.70**

Air Quality Impacts

Urban trees improve air quality in five fundamental ways:

- Absorption of gaseous pollutants such as ozone (O_3), sulfur dioxide (SO_2), and nitrogen dioxide (NO2) through leaf surfaces
- Interception of particulate matter (PM_{10}), such as dust, ash, dirt, pollen, and smoke
- Reduction of emissions from power generation by reducing energy consumption
- 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 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 and can cause respiratory problems.

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 various biogenic volatile organic compounds (BVOCs), such as isoprene's and monoterpenes, which also contribute to ozone formation. i-Tree *Streets* analysis accounts for these BVOC emissions in the air quality cumulative benefit.

Deposition and Interception

Each year, 4.17 tons of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), small particulate matter (PM_{10}), and ozone (O_3) are intercepted or absorbed by community trees, valued at $97,026 (Table 9). As a population, coast redwood (*Sequoia sempervirens*, 2,387 lbs) is the greatest contributor to pollutant deposition and interception, accounting for 29% of deposition and interception benefits.

Avoided Pollutants

The 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 1,490 pounds of pollutants, valued at $14,476, are avoided annually through the shading effects trees.

BVOC Emissions

Biogenic volatile organic compound (BVOC) emissions from trees, which negatively affect air quality, must also be considered along with the benefits. Approximately 7,004 pounds of BVOCs are emitted annually from community trees, reducing air quality with a value of -$32,848. Of the Prevalent Species, the heaviest emitters by population are coast live oak (*Quercus agrifolia*) emitting 43% of BVOCs. This produces an air quality impact valued at -$2.60 per tree.

Cumulative Air Quality Impact

The cumulative value of the annual air quality impact by trees in Los Altos is $78,654 annually. The overall average annual air quality impact per tree is $12.15.

To improve community air quality, as trees that emit high levels of BVOCs mature and decline, future tree planting should emphasize planting large-canopied trees with large leaf surface areas that are typically not high emitters of BVOCs. California peppertree (*Schinus molle*) and Chinaberry (*Melia azedarach*) provide the highest net per-tree benefit (Figure 10).

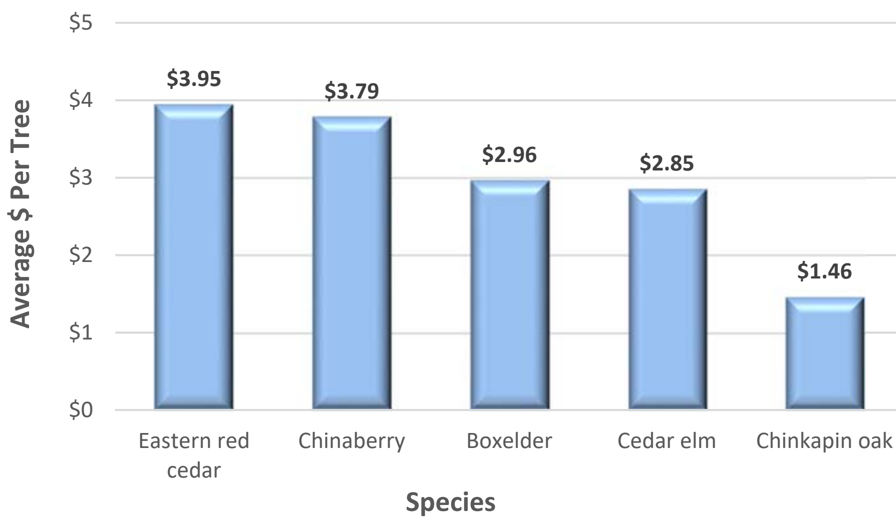


Figure 10. Annual Air Quality Benefits of Top Performers

The overall average annual air quality impact per tree is $12.15.

Table 9. Summary of Annual Air Quality Benefits from Most Prevalent Species (lb)

Species	Deposition O_3 (lb)	Deposition NO_2 (lb)	Deposition PM_{10} (lb)	Deposition Total (lb)	Avoided NO_2 (lb)	Avoided PM_{10} (lb)	Avoided VOC (lb)	Avoided SO_2 (lb)	Avoided Total (lb)	BVOC Emissions (lb)
Coast live oak	753	215	536	1,505	143.93	28.40	7.08	69.38	249	-2,977
Coast redwood	1,195	341	851	2,387	233.73	43.57	11.57	102.88	392	-551
Chinese pistache	497	120	248	865	108.13	21.23	5.32	51.69	186	-546
Olive	140	40	100	280	28.62	5.72	1.41	14.06	50	0
Apricot	81	21	47	149	19.53	3.62	0.97	8.52	33	0
Cherry plum	25	6	12	43	5.02	0.96	0.25	2.31	9	0
Sweetgum	76	18	37	131	20.94	4.21	1.03	10.40	37	-624
California laurel	47	13	33	94	8.65	1.71	0.43	4.17	15	-197
Silver	204	58	145	407	39.31	7.71	1.94	18.75	68	-837
Monterey pine	204	58	145	408	41.64	7.75	2.06	18.30	70	-99
Canary Island pine	136	39	97	271	29.65	5.62	1.47	13.41	50	-73
Flowering pear	50	13	29	92	12.09	2.24	0.60	5.26	20	0
Buckeye	25	7	15	47	6.05	1.12	0.30	2.64	10	0
Chinese privet	34	10	24	67	6.63	1.26	0.33	3.01	11	0
Deodar cedar	82	24	59	165	17.12	3.24	0.85	7.73	29	-42
Crapemyrtle	6	1	3	11	1.19	0.23	0.06	0.54	2	0
Holly oak	53	15	38	107	10.56	2.09	0.52	5.12	18	-170
California black walnut	76	18	38	132	15.06	2.89	0.74	6.93	26	0
London plane tree	44	11	25	80	9.59	1.80	0.47	4.27	16	-71
Victorian box	17	5	12	34	3.37	0.64	0.17	1.55	6	0
Valley oak	41	12	29	82	7.65	1.51	0.38	3.69	13	-180
Southern magnolia	24	7	17	49	5.51	1.03	0.27	2.42	9	-47
Black acacia	28	8	20	56	5.50	1.09	0.27	2.67	10	0
California peppertree	52	15	37	104	9.60	1.88	0.47	4.58	17	0
Green wattle	25	7	18	50	4.96	0.94	0.25	2.24	8	0
Japanese maple	10	2	5	17	2.37	0.48	0.12	1.20	4	-2
Plum	4	1	2	6	0.71	0.14	0.03	0.32	1	0
Tulip tree	19	4	9	32	4.87	0.96	0.24	2.35	8	-177
All other species	357	94	219	670	72.93	13.99	3.60	33.63	124	-409
Citywide Total	**4,305**	**1,182**	**2,852**	**8,340**	**874.88**	**168.03**	**43.17**	**404.04**	**1,490**	**-7,004**

Table 10. Summary of Annual Air Quality Benefits from Most Prevalent Species ($)

Species	Total Deposition ($)	Total Avoided ($)	BVOC Emissions ($)	Net Air Quality Impact ($)	% of Pop.	Avg. $/tree
Coast live oak	17,432	2,399	-13,962	5,870	17.67	5.13
Coast redwood	27,649	3,836	-2,582	28,903	14.54	30.72
Chinese pistache	10,218	1,800	-2,563	9,455	10.88	13.43
Olive	3,249	479	0	3,728	4.84	11.91
Apricot	1,751	320	0	2,071	4.17	7.67
Cherry plum	512	83	0	595	3.54	2.60
Sweetgum	1,555	351	-2,928	-1,022	3.18	-4.96
California laurel	1,085	144	-924	305	3.03	1.56
Silver	4,717	654	-3,926	1,445	2.64	8.45
Monterey pine	4,728	683	-465	4,946	2.60	29.44
Canary Island pine	3,140	489	-345	3,284	2.60	19.55
Flowering pear	1,081	198	0	1,279	1.93	10.24
Buckeye	549	99	0	648	1.85	5.40
Chinese privet	776	109	0	886	1.82	7.50
Deodar cedar	1,907	282	-197	1,992	1.54	19.92
Crapemyrtle	124	20	0	144	1.42	1.56
Holly oak	1,237	176	-799	615	1.30	7.32
California black walnut	1,557	249	0	1,806	1.19	23.45
London plane tree	936	158	-334	759	1.07	11.01
Victorian box	396	56	0	451	0.99	7.05
Valley oak	945	127	-844	228	0.90	3.93
Southern magnolia	567	90	-218	439	0.82	8.28
Black acacia	652	92	0	744	0.80	14.30
California peppertree	1,202	160	0	1,362	0.62	34.04
Green wattle	583	82	0	664	0.60	17.04
Japanese maple	197	40	-11	226	0.57	6.11
Plum	72	12	0	84	0.56	2.33
Tulip tree	379	81	-831	-371	0.51	-11.24
All other species	7,830	1,206	-1,920	7,117	11.83	1.58
Citywide Total	**$97,026**	**$14,476**	**-$32,848**	**$78,654**	**100%**	**$12.15**

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.

Trees in the Los Altos intercept almost 6.7 million gallons of stormwater annually for an average of 1,031 gallons per tree (Table 11). The total value of this benefit to the community is $52,070, an average of $8.04 per tree.

Overall, among Prevalent Species, California peppertree (*Schinus molle*) currently provides the greatest per tree benefit of $24.42, followed by coast redwood (*Sequoia sempervirens*, $17.85) (Figure 11). The population of coast redwood provides the largest portion of stormwater benefit at 32%. This value is understandable on their large stature, evergreen habit, and with their prevalence in the population, as they represent 18% of all trees. Evergreen trees often capture stormwater well because they retain their leaves through the rainiest months.

As trees grow, their benefits tend to increase, but some species will ultimately realize more substantial benefits than others will. Some tree species currently demonstrating lower benefits, such as plum (*Prunus* spp.), are small-canopied deciduous trees. As such, their benefits will not increase much over time. Other species, such as California laurel (*Umbellularia californica*) are a young population of trees that will develop a large, evergreen canopy at maturity. The stormwater benefit of this population should be expected to increase barring any emerging pests or diseases which may impact this population.

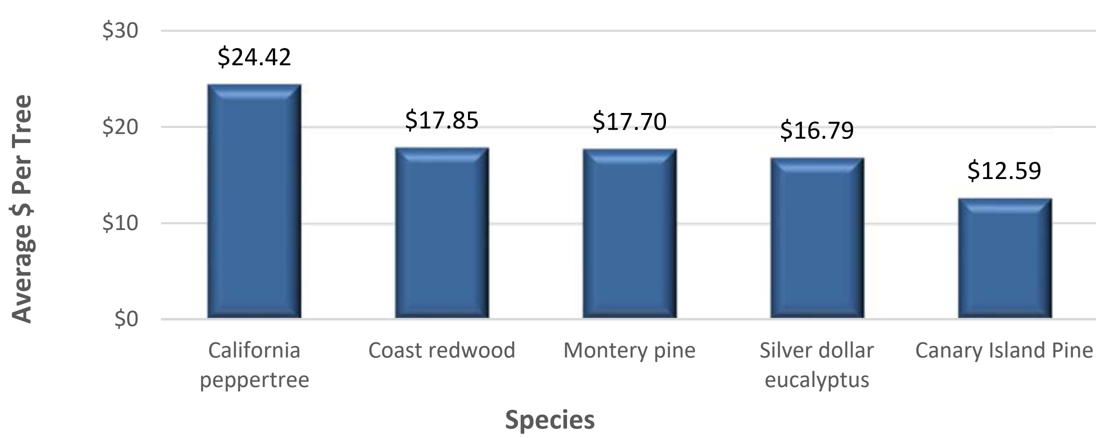


Figure 11. Annual Stormwater Benefits of Top Performers

Table 11. Summary of Annual Stormwater Benefits of Most Prevalent Species

Species	Total Rainfall Interception (Gal)	Total ($)	% of Pop.	% of Total $	Avg. $/tree
Coast live oak	1,312,741	10,239	17.67	19.66	8.95
Coast redwood	2,154,031	16,801	14.54	32.27	17.85
Chinese pistache	391,473	3,053	10.88	5.86	4.34
Olive	199,047	1,553	4.84	2.98	4.96
Apricot	82,272	642	4.17	1.23	2.38
Cherry plum	21,292	166	3.54	0.32	0.73
Sweetgum	70,662	551	3.18	1.06	2.68
California laurel	83,111	648	3.03	1.24	3.31
Silver dollar eucalyptus	368,077	2,871	2.64	5.51	16.79
Monterey pine	381,304	2,974	2.60	5.71	17.70
Canary Island pine	271,244	2,116	2.60	4.06	12.59
Flowering pear	50,142	391	1.93	0.75	3.13
Buckeye	26,226	205	1.85	0.39	1.70
Chinese privet	53,044	414	1.82	0.79	3.51
Deodar cedar	158,263	1,234	1.54	2.37	12.34
Crapemyrtle	5,142	40	1.42	0.08	0.44
Holly oak	83,149	649	1.30	1.25	7.72
California black walnut	64,750	505	1.19	0.97	6.56
London plane tree	45,376	354	1.07	0.68	5.13
Victorian box	27,788	217	0.99	0.42	3.39
Valley oak	75,435	588	0.90	1.13	10.14
Southern magnolia	39,804	310	0.82	0.60	5.86
Black acacia	51,122	399	0.80	0.77	7.67
California peppertree	125,244	977	0.62	1.88	24.42
Green wattle	37,731	294	0.60	0.57	7.55
Japanese maple	7,583	59	0.57	0.11	1.60
Plum	3,000	23	0.56	0.04	0.65
Tulip tree	17,456	136	0.51	0.26	4.13
All other species	469,073	3,659	11.83	7.03	4.78
Citywide total	**6,675,584**	**$52,070**	**100%**	**100%**	**$8.04**

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 the Los Altos' community trees associated with property value increases and other less tangible benefits is $4.5 million, an average of $700 per tree (Table 12). Overall, among prevalent species, California peppertree (*Schinus molle*, $1,362), and tulip tree (*Liriodendron tulipifera*, $1,346) provide the greatest per-tree aesthetic value annually (Figure 12).

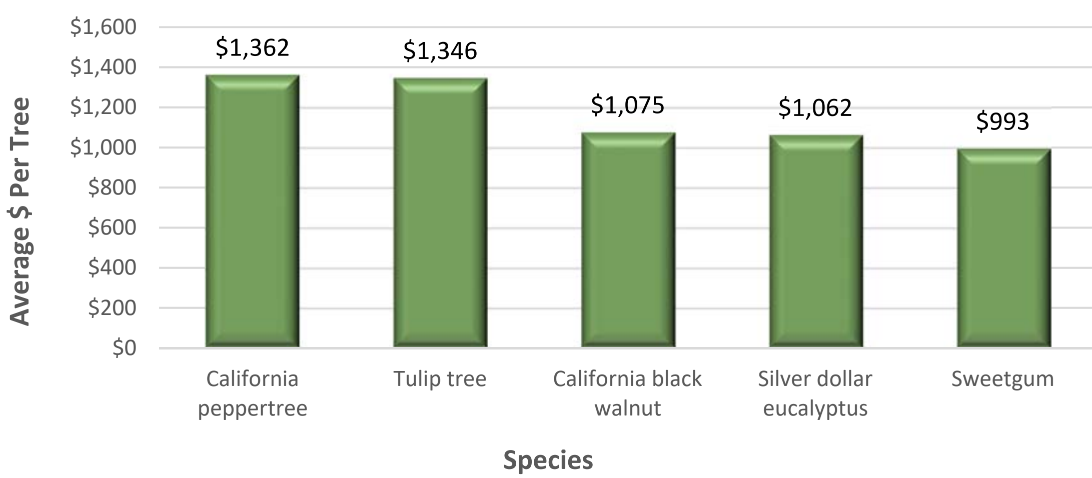


Figure 12. Annual Aesthetic Benefits of Top Performers

Table 12. Annual Aesthetic, Property Value, & Socioeconomic Benefits of Most Prevalent Species

Species	Total ($)	% of Pop.	% of Total $	Avg. $/tree
Coast live oak	839,624	17.67	18.53	733.94
Coast redwood	799,629	14.54	17.65	849.77
Chinese pistache	533,539	10.88	11.77	757.87
Olive	204,030	4.84	4.50	651.85
Apricot	154,363	4.17	3.41	571.71
Cherry plum	20,271	3.54	0.45	88.52
Sweetgum	204,560	3.18	4.51	993.01
California laurel	97,178	3.03	2.14	495.81
Silver dollar eucalyptus	181,561	2.64	4.01	1,061.76
Monterey pine	144,171	2.60	3.18	858.16
Canary Island pine	148,593	2.60	3.28	884.48
Flowering pear	61,729	1.93	1.36	493.83
Buckeye	78,932	1.85	1.74	657.76
Chinese privet	57,927	1.82	1.28	490.91
Deodar cedar	86,762	1.54	1.91	867.62
Crapemyrtle	8,259	1.42	0.18	89.77
Holly oak	61,723	1.30	1.36	734.80
California black walnut	82,774	1.19	1.83	1,074.99
London plane tree	55,660	1.07	1.23	806.67
Victorian box	31,086	0.99	0.69	485.72
Valley oak	41,351	0.90	0.91	712.95
Southern magnolia	12,674	0.82	0.28	239.13
Black acacia	38,245	0.80	0.84	735.48
California peppertree	54,481	0.62	1.20	1,362.03
Green wattle	22,589	0.60	0.50	579.21
Japanese maple	32,719	0.57	0.72	884.29
Plum	3,142	0.56	0.07	87.28
Tulip tree	44,412	0.51	0.98	1,345.82
All other species	429,154	11.83	9.47	560.25
Citywide Total/Average	**$4,531,139**	**100%**	**100%**	**$700.01**

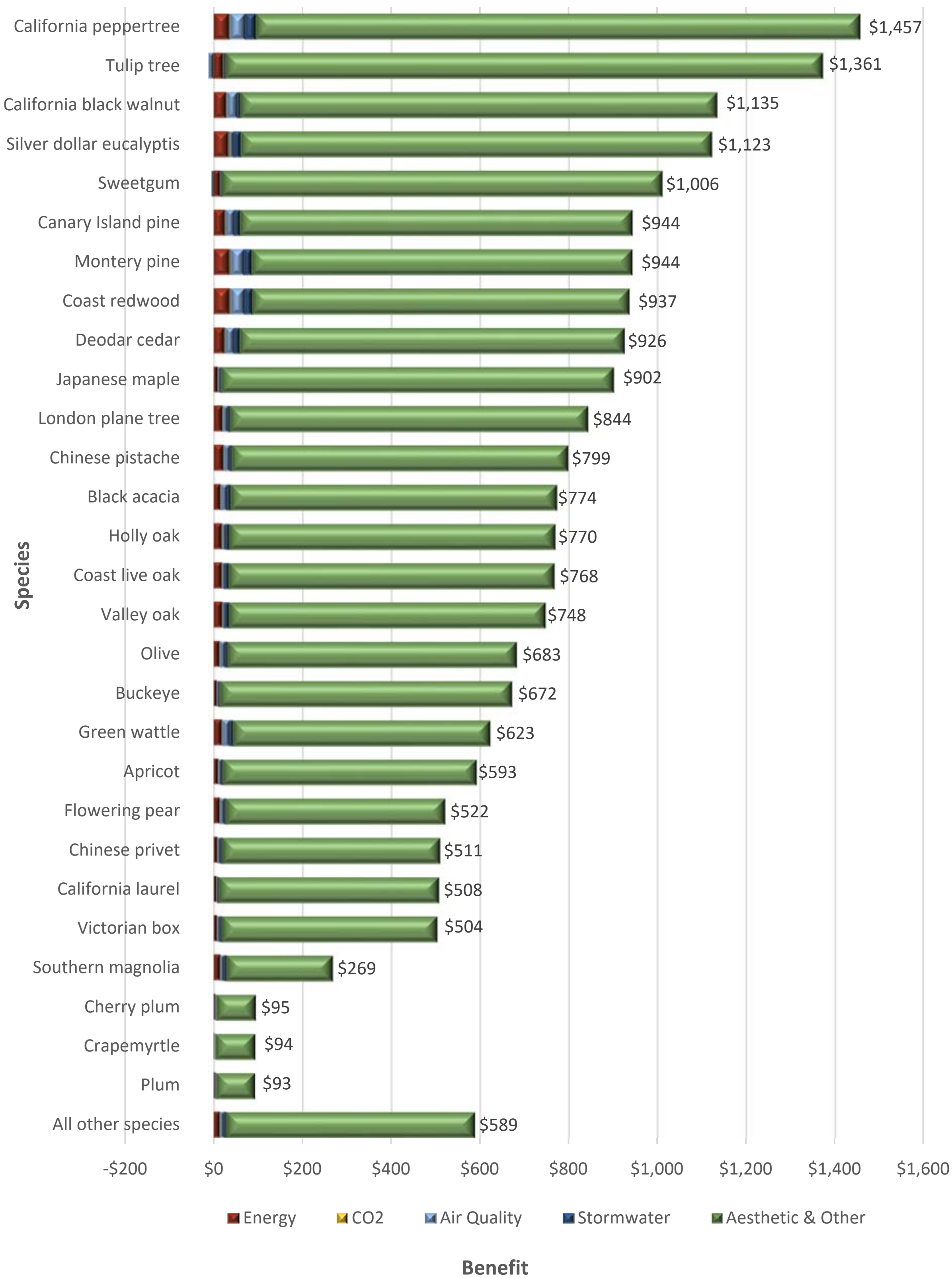


Figure 13. Summary of Annual Per-Tree Benefits of Most Prevalent Species

Table 13. Summary of Annual Per-Tree Benefits of Most Prevalent Species

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic & Other	Total
Coast live oak	18.09	2.02	5.13	8.95	733.94	768.12
Coast redwood	35.35	3.28	30.72	17.85	849.77	936.96
Chinese pistache	22.03	1.25	13.43	4.34	757.87	798.92
Olive	13.13	1.38	11.91	4.96	651.85	683.23
Apricot	10.26	0.67	7.67	2.38	571.71	592.69
Cherry plum	3.20	0.16	2.60	0.73	88.52	95.21
Sweetgum	14.44	1.30	-4.96	2.68	993.01	1,006.46
California laurel	6.37	0.81	1.56	3.31	495.81	507.84
Silver dollar eucalyptis	32.95	3.21	8.45	16.79	1,061.76	1,123.16
Monterey pine	35.19	3.29	29.44	17.70	858.16	943.79
Canary Island pine	25.02	2.33	19.55	12.59	884.48	943.97
Flowering pear	13.71	0.85	10.24	3.13	493.83	521.76
Buckeye	7.15	0.48	5.40	1.70	657.76	672.50
Chinese privet	8.05	0.56	7.50	3.51	490.91	510.53
Deodar cedar	24.33	2.26	19.92	12.34	867.62	926.48
Crapemyrtle	1.89	0.10	1.56	0.44	89.77	93.75
Holly oak	18.06	2.24	7.32	7.72	734.80	770.13
California black walnut	28.11	1.85	23.45	6.56	1,074.99	1,134.96
London plane tree	19.87	1.26	11.01	5.13	806.67	843.93
Victorian box	7.56	0.53	7.05	3.39	485.72	504.24
Valley oak	18.97	1.96	3.93	10.14	712.95	747.97
Southern magnolia	14.72	0.81	8.28	5.86	239.13	268.80
Black acacia	15.19	1.42	14.30	7.67	735.48	774.06
California peppertree	34.50	2.30	34.04	24.42	1,362.03	1,457.29
Green wattle	18.20	1.33	17.04	7.55	579.21	623.31
Japanese maple	9.18	0.81	6.11	1.60	884.29	901.99
Plum	2.87	0.14	2.33	0.65	87.28	93.27
Tulip tree	20.97	1.79	-11.24	4.13	1,345.82	1,361.47
All other species	13.65	0.98	9.29	4.78	560.25	588.95
Citywide Average	**$19.32**	**$1.70**	**$12.15**	**$8.04**	**$700.01**	**$741.22**

Net Benefits and Benefit versus Investment Ratio (BIR)

Benefits

Los Altos receives substantial benefits from their community urban forest (Table 14, Figure 14); however, the city must also consider their investments in maintaining this resource. 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 the city's trees, compared to the cost associated with their management.

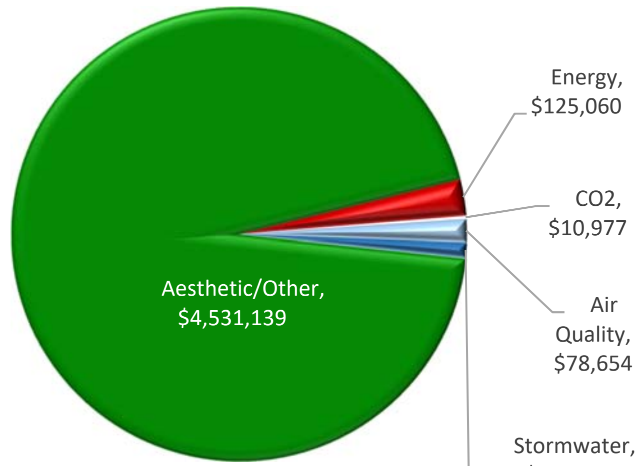


Figure 14. Annual Benefits from Los Altos' Trees

Total Annual Benefits: $4.8 million

Average Annual Per-Tree Benefit: $741

Average Annual Per-Capita Benefit: $159

Los Altos community trees provide $4,797,900 in annual benefits, a value of $741 per tree and $159 per capita. Of the total benefits provided by community trees, approximately $266,761 of the annual benefits (6%) quantified in this study are directly related to the environment (Table 14). The remainder of the total annual benefits, $4,531,139 (94%), are related to aesthetic and socioeconomic benefits such as increased property values.

It is important to acknowledge that this is not a full accounting of the benefits provided by this 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. Therefore, the actual benefits of these community trees are likely to be higher than estimated in this analysis.

Investment

Investment costs were provided by Los Altos. The total annual cost of managing the tree resource is $405,000, or $73/tree. This includes many aspects of tree care and management, including fleet, equipment, contract pruning, administration, litter clean-up, planting, irrigation, liability and claims, removal, infrastructure repairs, and pest management as well as personnel and administrative salaries.

BIR

When the city's annual estimated expenditure (or investment) of $405,500 in this resource is considered, the net annual benefit (benefits minus investment) to the city is $4,392,900. The average net benefit for an individual community tree at Los Altos is $679 (Table 14). The average per capita net benefit provided by community trees is $143. **Each year, Los Altos receives $11.85 in benefits for every $1 invested in community trees.**

Table 14. Benefits and Investments in Los Altos Urban Forest

Benefits	Total ($)	$/tree	$/capita
Energy	125,060	19.32	4.14
CO2	10,977	1.70	0.36
Air Quality	78,654	12.15	2.61
Stormwater	52,070	8.04	1.73
Aesthetic/Other	4,531,139	700.01	150.15
Total Benefits	**$4,797,900**	**$741.22**	**$158.99**
Costs			
Personnel	277,000	42.79	9.18
Fleet and Equipment	45,000	6.95	1.49
Contract Pruning	25,000	3.86	0.83
Administration	15,000	2.32	0.50
Litter Clean-up	15,000	2.32	0.50
Planting	7,500	1.16	2.49
Irrigation	6,000	0.93	0.20
Liability/Claims	6,000	0.93	0.20
Removal	5,000	0.77	0.17
Infrastructure Repairs	2,500	0.39	0.08
Pest Management	1,000	0.15	0.03
Total Costs	**$405,000**	**$62.57**	**$15.66**
Net Benefit	**$4,392,900**	**$678.65**	**$143.33**
Benefit-Investment Ratio			**11.85**

Conclusion

This analysis describes the current structural characteristics of Los Altos' community tree resource, using established tree sampling, 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. Rather than examining each individual tree, as an inventory does, the resource analysis examines trends and performance measures over the entire urban forest and each of the major species populations within. Community trees are providing quantifiable impacts on air quality, reduction in atmospheric CO_2, stormwater runoff, and aesthetic benefits. The 6,473 trees provide cumulative annual benefits worth $4.8 million, a value of $741 per tree and $159 per capita.

Los Altos' community tree population has a nearly ideal age distribution of young to established trees in fair to good condition. The resource has a healthy diversity with more than 152 different species, however heavily relies on one species (live oak) for almost half the tree benefits. Los Altos should continue to focus resources on preserving existing and mature trees to promote health, strong structure, tree longevity, and manage risk. Structural and training pruning for young trees will maximize the value of this resource, reduce long-term maintenance costs, and ensure that as trees mature they provide the greatest possible benefits over time.

Based on this resource analysis, Davey Resource Group recommends the following:

- Increase species diversity by insuring that new tree plantings include a variety of suitable species and don't unduly increase reliance on Prevalent Species.
- Use all available planting sites to improve diversity and increase benefits. Install large-stature species wherever space allows.
- 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.
- 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 current status of the community tree population. Managers can also anticipate challenges and devise plans to increase the current level of benefits. Performance data from the analysis can be used to make determinations regarding species selection, distribution, and maintenance policies. Documenting current structure is necessary for establishing goals and performance objectives and can serve as a benchmark for measuring future success. Information from the urban forest resource analysis can be referenced in development of an urban forest management or master plan. An urban forest master plan is a critical tool for successful urban forest management, providing a shared community vision for the tree resource.

Los Altos' community trees are of vital importance to the environmental, social, and economic well-being of the community. Los Altos Urban Forest Managers have demonstrated that community trees are a valued community resource, a vital component of the community infrastructure, and an important part of the city's identity. The inventory data can be used to plan a proactive and forward-looking approach to the future care of community trees. Updates should continue to be incorporated into the inventory a 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 community and community at large.

The 6,473 trees provide cumulative annual benefits worth $4.8 million, a value of $741 per tree and $159 per capita.

Appendix A: Methodology

In 2016, Certified Arborists collected an inventory of the community trees in parks and in select street medians, including details about each tree's species, size, and condition. The inventory data was formatted for use in i-Tree's public tree population assessment tool, i-Tree *Streets*, a STRATUM Analysis Tool (*Streets* v 5.1.5; i-Tree v 6.1.16). i-Tree *Streets* assesses tree population structure and the function of those trees, such as their role in building energy use, air pollution removal, stormwater interception, carbon dioxide removal, and property value increases. To analyze the economic benefits of Los Altos' community trees, i-Tree *Streets* calculates the dollar value of annual resource functionality. This analysis combines the results of the community 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 (Los Altos is located in the Northern California Coast Zone, and the reference city is Berkeley.

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. Community urban forest managers provided the estimated investment costs for contracted and in-house tree services, pest management, administration, and inspections.

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.

Table 15. Benefit Prices Used in This Analysis

Benefits	Price	Unit	Source
Electricity	0.1559	$/Kwh	PG&E Residential
Natural Gas	1.205	$/Therm	PG&E Residential
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 Value	2,787,000	$	City of Los Altos

i-Tree *Streets* default values (Table 15) from the Northern California Coast Zone 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 inventoried tree resource was calculated using i-Tree *Streets***.** Median home value, electrical and gas rates, and program investment costs were supplied by Los Altos urban forest managers.

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. 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. Heat Island Effect. *www.epa.gov/heatisland/about/index.htm*

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

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

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

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 16. DBH Distribution and RPI for All Tree Species

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total	% of Pop.
Broadleaf Deciduous Large (BDL)											
Sweetgum	1	9	119	68	8	1	0	0	0	**206**	**3.18%**
California black walnut	1	7	19	33	11	2	3	1	0	**77**	**1.19%**
London plane tree	6	9	34	9	7	2	2	0	0	**69**	**1.07%**
Valley oak	1	7	28	11	2	4	2	2	1	**58**	**0.90%**
Tulip tree	0	1	9	14	6	3	0	0	0	**33**	**0.51%**
Siberian elm	7	10	7	1	1	0	0	0	0	**26**	**0.40%**
Chinese elm	3	7	9	5	0	0	0	0	0	**24**	**0.37%**
Northern red oak	4	5	6	0	0	0	0	0	0	**15**	**0.23%**
Evergreen ash	1	3	3	2	3	0	0	0	0	**12**	**0.19%**
Silver maple	0	0	0	1	6	1	1	0	0	**9**	**0.14%**
Scarlet oak	2	3	2	1	0	0	0	0	0	**8**	**0.12%**
Honeylocust	0	2	5	0	0	0	0	0	0	**7**	**0.11%**
White poplar	1	2	0	2	1	0	0	0	0	**6**	**0.09%**
American sycamore	0	0	0	0	0	0	1	0	3	**4**	**0.06%**
Bigleaf maple	0	2	1	1	0	0	0	0	0	**4**	**0.06%**
Shumard oak	0	0	3	0	0	0	0	0	0	**3**	**0.05%**
Blue oak	0	1	0	0	1	0	1	0	0	**3**	**0.05%**
Modesto ash	0	0	1	0	2	0	0	0	0	**3**	**0.05%**
Lombardy poplar	0	0	2	0	0	0	0	0	0	**2**	**0.03%**
Elm	0	0	2	0	0	0	0	0	0	**2**	**0.03%**
European beech	2	0	0	0	0	0	0	0	0	**2**	**0.03%**
Dawn redwood	0	0	0	1	0	0	0	0	0	**1**	**0.02%**
Oak	0	0	0	0	1	0	0	0	0	**1**	**0.02%**
Western sycamore	0	0	0	1	0	0	0	0	0	**1**	**0.02%**
Pecan	0	0	0	1	0	0	0	0	0	**1**	**0.02%**
Fremont cottonwood	0	0	1	0	0	0	0	0	0	**1**	**0.02%**
BDL Total	**29**	**68**	**251**	**151**	**49**	**13**	**10**	**3**	**4**	**578**	**8.93%**
Broadleaf Deciduous Medium (BDM)											
Chinese pistache	45	94	314	229	20	2	0	0	0	**704**	**10.88%**
Apricot	48	79	116	26	0	0	0	0	1	**270**	**4.17%**
Flowering pear	10	20	74	21	0	0	0	0	0	**125**	**1.93%**
Buckeye	48	32	32	6	2	0	0	0	0	**120**	**1.85%**

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total	% of Pop.
Other species	1	12	8	1	0	0	1	0	0	**23**	**0.36%**
English walnut	1	1	7	6	2	1	0	0	0	**18**	**0.28%**
Ginkgo	13	4	0	0	0	0	0	0	0	**17**	**0.26%**
Willow	0	3	5	3	5	1	0	0	0	**17**	**0.26%**
Japanese zelkova	0	0	0	5	4	2	0	0	0	**11**	**0.17%**
Red horse chestnut	0	0	10	0	0	0	0	0	0	**10**	**0.15%**
Purple robe locust	0	2	7	1	0	0	0	0	0	**10**	**0.15%**
White mulberry	0	0	0	2	1	3	0	0	0	**6**	**0.09%**
Tree of heaven	1	3	2	0	0	0	0	0	0	**6**	**0.09%**
Raywood ash	0	0	3	3	0	0	0	0	0	**6**	**0.09%**
Black locust	0	1	1	3	0	0	0	0	0	**5**	**0.08%**
European white birch	1	0	1	3	0	0	0	0	0	**5**	**0.08%**
Japanese persimmon	0	0	2	3	0	0	0	0	0	**5**	**0.08%**
Red maple	2	2	0	0	0	0	0	0	0	**4**	**0.06%**
Jacaranda	4	0	0	0	0	0	0	0	0	**4**	**0.06%**
Goldenrain tree	1	1	0	0	0	0	0	0	0	**2**	**0.03%**
Chinaberry	1	0	0	0	0	0	0	0	0	**1**	**0.02%**
Flame tree	0	0	1	0	0	0	0	0	0	**1**	**0.02%**
Little-leaf linden	0	0	0	0	1	0	0	0	0	**1**	**0.02%**
Mimosa	0	0	1	0	0	0	0	0	0	**1**	**0.02%**
BDM Total	**176**	**254**	**584**	**312**	**35**	**9**	**1**	**0**	**1**	**1,372**	**21.20%**
Broadleaf Deciduous Small (BDS)											
Cherry plum	52	123	51	3	0	0	0	0	0	**229**	**3.54%**
Crapemyrtle	54	28	9	1	0	0	0	0	0	**92**	**1.42%**
Japanese maple	7	19	11	0	0	0	0	0	0	**37**	**0.57%**
Plum	11	18	6	1	0	0	0	0	0	**36**	**0.56%**
Hollyleaf cherry	4	5	6	2	0	0	0	0	0	**17**	**0.26%**
Catalina cherry	1	12	4	0	0	0	0	0	0	**17**	**0.26%**
Japanese flowering cherry	2	5	9	0	0	0	0	0	0	**16**	**0.25%**
Eastern redbud	4	4	1	0	0	0	0	0	0	**9**	**0.14%**
Eastern dogwood	7	0	0	0	0	0	0	0	0	**7**	**0.11%**
Smooth hawthorn	1	3	1	0	0	0	0	0	0	**5**	**0.08%**
Peach	5	0	0	0	0	0	0	0	0	**5**	**0.08%**
Almond	1	1	3	0	0	0	0	0	0	**5**	**0.08%**
Saucer magnolia	1	2	0	1	0	0	0	0	0	**4**	**0.06%**
Flowering plum	0	4	0	0	0	0	0	0	0	**4**	**0.06%**

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total	% of Pop.
Chitalpa	0	1	3	0	0	0	0	0	0	**4**	**0.06%**
Pomegranate	2	0	0	0	0	0	0	0	0	**2**	**0.03%**
Flowering crabapple	0	2	0	0	0	0	0	0	0	**2**	**0.03%**
Japanese flowering crabapple	1	1	0	0	0	0	0	0	0	**2**	**0.03%**
Common crabapple	1	0	0	0	0	0	0	0	0	**1**	**0.02%**
Kwanzan cherry	0	0	0	1	0	0	0	0	0	**1**	**0.02%**
Common fig	0	1	0	0	0	0	0	0	0	**1**	**0.02%**
Desert willow	1	0	0	0	0	0	0	0	0	**1**	**0.02%**
BDS Total	**155**	**229**	**104**	**9**	**0**	**0**	**0**	**0**	**0**	**497**	**7.68%**
Broadleaf Evergreen Large (BEL)											
Coast live oak	48	234	379	224	147	59	30	10	13	**1,144**	**17.67%**
California laurel	79	54	41	13	3	1	1	1	3	**196**	**3.03%**
Silver dollar eucalyptus	0	5	18	52	49	38	8	1	0	**171**	**2.64%**
Holly oak	0	20	21	24	17	2	0	0	0	**84**	**1.30%**
Blue gum	0	0	4	0	2	6	1	2	5	**20**	**0.31%**
Cork oak	8	8	0	2	1	0	0	0	0	**19**	**0.29%**
Southern live oak	0	0	2	0	4	3	0	0	0	**9**	**0.14%**
Gum	0	0	1	0	2	2	0	0	0	**5**	**0.08%**
Red ironbark	0	0	2	1	0	0	0	0	0	**3**	**0.05%**
Red gum	0	0	0	1	1	0	1	0	0	**3**	**0.05%**
Silk oak	0	0	0	1	2	0	0	0	0	**3**	**0.05%**
Total	**135**	**321**	**468**	**318**	**228**	**111**	**41**	**14**	**21**	**1,657**	**25.60%**
Broadleaf Evergreen Medium (BEM)											
Olive	13	15	226	43	12	3	1	0	0	**313**	**4.84%**
Southern magnolia	6	1	16	26	3	1	0	0	0	**53**	**0.82%**
Black acacia	1	12	25	6	3	4	0	1	0	**52**	**0.80%**
California peppertree	0	2	5	8	9	8	3	1	4	**40**	**0.62%**
Fern pine	7	14	2	0	0	1	0	0	0	**24**	**0.37%**
Camphor tree	0	1	5	8	2	3	0	0	0	**19**	**0.29%**
Cajeput tree	0	2	16	0	0	0	0	0	0	**18**	**0.28%**
Carob	0	0	1	2	4	3	1	0	0	**11**	**0.17%**
Mayten tree	0	2	2	0	0	0	0	0	0	**4**	**0.06%**
Magnolia	2	0	0	0	0	0	0	0	0	**2**	**0.03%**

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total	% of Pop.
Catalina ironwood	0	1	0	1	0	0	0	0	0	**2**	**0.03%**
Pacific madrone	0	0	0	0	1	0	0	0	0	**1**	**0.02%**
Canyon live oak	0	0	0	1	0	0	0	0	0	**1**	**0.02%**
California privet	0	1	0	0	0	0	0	0	0	**1**	**0.02%**
Bay laurel	1	0	0	0	0	0	0	0	0	**1**	**0.02%**
Total	**30**	**51**	**298**	**95**	**34**	**23**	**5**	**2**	**4**	**542**	**8.37%**
Broadleaf Evergreen Small (BES)											
Chinese privet	24	41	46	7	0	0	0	0	0	**118**	**1.82%**
Victorian box	3	36	24	1	0	0	0	0	0	**64**	**0.99%**
Green wattle	1	4	17	12	3	2	0	0	0	**39**	**0.60%**
Yew pine	26	0	0	0	0	0	0	0	0	**26**	**0.40%**
Strawberry marina tree	11	8	1	0	0	0	0	0	0	**20**	**0.31%**
Tarata	1	9	9	0	0	0	0	0	0	**19**	**0.29%**
Holly	3	12	0	0	0	0	0	0	0	**15**	**0.23%**
Longleafed yellow wood	11	2	0	0	0	0	0	0	0	**13**	**0.20%**
Evergreen pear	2	0	6	3	0	0	0	0	0	**11**	**0.17%**
Silver wattle	2	3	5	1	0	0	0	0	0	**11**	**0.17%**
Brisbane box	6	4	0	0	0	0	0	0	0	**10**	**0.15%**
Fraser photinia	0	9	0	0	0	0	0	0	0	**9**	**0.14%**
Water gum	1	6	0	0	0	0	0	0	0	**7**	**0.11%**
Bronze loquat	1	6	0	0	0	0	0	0	0	**7**	**0.11%**
Strawberry tree	0	4	2	0	0	0	0	0	0	**6**	**0.09%**
Xylosma	0	0	4	0	0	0	0	0	0	**4**	**0.06%**
Sydney golden wattle	0	2	1	0	0	0	0	0	0	**3**	**0.05%**
Cherry laurel	1	1	0	0	0	0	0	0	0	**2**	**0.03%**
Japanese loquat	1	1	0	0	0	0	0	0	0	**2**	**0.03%**
Black stem pittosporum	0	0	2	0	0	0	0	0	0	**2**	**0.03%**
Indian hawthorn	0	2	0	0	0	0	0	0	0	**2**	**0.03%**
Brazilian peppertree	0	0	1	0	0	0	0	0	0	**1**	**0.02%**
Toyon	0	0	1	0	0	0	0	0	0	**1**	**0.02%**
Firethorn	1	0	0	0	0	0	0	0	0	**1**	**0.02%**
Italian buckthorn	0	1	0	0	0	0	0	0	0	**1**	**0.02%**
Lemon	0	1	0	0	0	0	0	0	0	**1**	**0.02%**
California wild lilac	1	0	0	0	0	0	0	0	0	**1**	**0.02%**
Spanish dagger	0	0	1	0	0	0	0	0	0	**1**	**0.02%**

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total	% of Pop.
Pineapple guava	1	0	0	0	0	0	0	0	0	**1**	**0.02%**
Total	**97**	**152**	**120**	**24**	**3**	**2**	**0**	**0**	**0**	**398**	**6.15%**
Conifers											
Coast redwood	27	40	74	129	182	180	153	82	74	**941**	**14.54%**
Canary Island pine	2	9	13	48	67	22	6	1	0	**168**	**2.60%**
Monterey pine	3	1	5	22	46	53	28	5	5	**168**	**2.60%**
Deodar cedar	5	6	19	22	25	10	8	3	2	**100**	**1.54%**
Pine	1	1	1	2	0	0	0	0	0	**5**	**0.08%**
Italian cypress	0	1	0	2	1	0	0	0	0	**4**	**0.06%**
Italian stone pine	0	1	0	1	0	0	1	0	0	**3**	**0.05%**
Mt. Atlas cedar	1	0	0	0	0	1	1	0	0	**3**	**0.05%**
Japanese black pine	0	2	0	0	0	0	0	0	0	**2**	**0.03%**
Incense cedar	0	0	0	0	0	1	0	1	0	**2**	**0.03%**
Douglas fir	0	0	0	0	0	0	1	0	0	**1**	**0.02%**
Bunya-bunya tree	0	0	0	0	0	0	0	0	1	**1**	**0.02%**
Arizona cypress	0	0	0	0	1	0	0	0	0	**1**	**0.02%**
River she-oak	0	0	0	0	0	1	0	0	0	**1**	**0.02%**
Aleppo pine	0	0	0	0	0	0	0	0	1	**1**	**0.02%**
Cypress	0	0	0	0	1	0	0	0	0	**1**	**0.02%**
Horsetail tree	0	0	0	0	1	0	0	0	0	**1**	**0.02%**
Turkish pine	0	0	0	1	3	0	0	0	0	**4**	**0.06%**
Port Orford cedar	0	0	1	0	0	0	0	0	0	**1**	**0.02%**
Juniper	1	0	0	0	0	0	0	0	0	**1**	**0.02%**
Hollywood juniper	0	0	1	0	0	0	0	0	0	**1**	**0.02%**
Total	**40**	**61**	**114**	**227**	**327**	**268**	**198**	**92**	**83**	**1,410**	**21.78%**
Palms											
Phoenix canariensis	0	0	1	0	3	7	4	1	0	**16**	**0.25%**
Date palm	0	0	0	0	0	1	0	0	0	**1**	**0.02%**
California palm	0	0	0	0	0	0	1	0	0	**1**	**0.02%**
Mexican fan palm	0	0	0	0	1	0	0	0	0	**1**	**0.02%**
Total	**0**	**0**	**1**	**0**	**4**	**8**	**5**	**1**	**0**	**19**	**0.29%**
Grand Total	**662**	**1,136**	**1,940**	**1,136**	**680**	**434**	**260**	**112**	**113**	**6,473**	**100%**

Table 17. Common Name, Botanical Name & Importance Value for All Tree Species

Common Name	Botanical Name	Number of Trees	% of Pop.	Importance Value
Coast live oak	*Quercus agrifolia*	1,144	17.67	17.36
Coast redwood	*Sequoia sempervirens*	941	14.54	22.96
Chinese pistache	*Pistacia chinensis*	704	10.88	11.22
Olive	*Olea europaea*	313	4.84	3.43
Apricot	*Prunus armeniaca*	270	4.17	2.62
Cherry plum	*Prunus cerasifera*	229	3.54	1.59
Sweetgum	*Liquidambar styraciflua*	206	3.18	2.65
California laurel	*Umbellularia californica*	196	3.03	1.75
Silver dollar eucalyptus	*Eucalyptus polyanthemos*	171	2.64	4.04
Monterey pine	*Pinus radiata*	168	2.60	4.04
Canary Island pine	*Pinus canariensis*	168	2.60	3.10
Flowering pear	*Pyrus calleryana*	125	1.93	1.39
Buckeye	*Aesculus californica*	120	1.85	1.02
Chinese privet	*Ligustrum lucidum*	118	1.82	1.07
Deodar cedar	*Cedrus deodara*	100	1.54	1.83
Crapemyrtle	*Lagerstroemia indica*	92	1.42	0.57
Holly oak	*Quercus ilex*	84	1.30	1.17
California black walnut	*Juglans hindsii*	77	1.19	1.66
London plane tree	*Platanus X hispanica*	69	1.07	1.03
Victorian box	*Pittosporum undulatum*	64	0.99	0.57
Valley oak	*Quercus lobata*	58	0.90	0.96
Southern magnolia	*Magnolia grandiflora*	53	0.82	0.62
Black acacia	*Acacia melanoxylon*	52	0.80	0.74
California peppertree	*Schinus molle*	40	0.62	1.41
Green wattle	*Acacia decurrens*	39	0.60	0.54
Japanese maple	*Acer palmatum*	37	0.57	0.33
Plum	*Prunus species*	36	0.56	0.24
Tulip tree	*Liriodendron tulipifera*	33	0.51	0.60
Siberian elm	*Ulmus pumila*	26	0.40	0.26
Yew pine	*Podocarpus macrophyllus*	26	0.40	0.15
Chinese elm	*Ulmus parvifolia*	24	0.37	0.29
Fern pine	*Podocarpus gracilior*	24	0.37	0.19
Other species	*other spp.*	23	0.36	0.23
Strawberry marina tree	*Arbutus 'Marina'*	20	0.31	0.13
Blue gum	*Eucalyptus globulus*	20	0.31	0.76
Tarata	*Pittosporum eugenioides*	19	0.29	0.17
Camphor tree	*Cinnamomum camphora*	19	0.29	0.33
Cork oak	*Quercus suber*	19	0.29	0.15
Cajeput tree	*Melaleuca quinquenervia*	18	0.28	0.17

Common Name	Botanical Name	Number of Trees	% of Pop.	Importance Value
English walnut	*Juglans regia*	18	0.28	0.27
Hollyleaf cherry	*Prunus ilicifolium*	17	0.26	0.13
Ginkgo	*Ginkgo biloba*	17	0.26	0.10
Catalina cherry	*Prunus ilicifolia lyonii*	17	0.26	0.12
Willow	*Salix species*	17	0.26	0.27
PHCA	*Phoenix canariensis*	16	0.25	0.25
Japanese flowering cherry	*Prunus serrulata*	16	0.25	0.13
Holly	*Ilex spp.*	15	0.23	0.11
Northern red oak	*Quercus rubra*	15	0.23	0.11
Longleafed yellow wood	*Podocarpus henkelii*	13	0.20	0.08
Evergreen ash	*Fraxinus uhdei*	12	0.19	0.18
Evergreen pear	*Pyrus kawakamii*	11	0.17	0.13
Silver wattle	*Acacia dealbata*	11	0.17	0.11
Carob	*Ceratonia siliqua*	11	0.17	0.38
Japanese zelkova	*Zelkova serrata*	11	0.17	0.35
Red horse chestnut	*Aesculus carnea*	10	0.15	0.11
Purple robe locust	*Robinia x ambigua*	10	0.15	0.11
Brisbane box	*Tristania conferta*	10	0.15	0.06
Eastern redbud	*Cercis canadensis*	9	0.14	0.06
Southern live oak	*Quercus virginiana*	9	0.14	0.22
Silver maple	*Acer saccharinum*	9	0.14	0.24
Fraser photinia	*Photinia x fraseri*	9	0.14	0.07
Scarlet oak	*Quercus coccinea*	8	0.12	0.06
Honeylocust	*Gleditsia triacanthos*	7	0.11	0.07
Bronze loquat	*Eriobotrya deflexa*	7	0.11	0.05
Eastern dogwood	*Cornus florida*	7	0.11	0.04
Water gum	*Tristania laurina*	7	0.11	0.05
White mulberry	*Morus alba*	6	0.09	0.13
White poplar	*Populus alba*	6	0.09	0.09
Tree of heaven	*Ailanthus altissima*	6	0.09	0.05
Strawberry tree	*Arbutus unedo*	6	0.09	0.05
Raywood ash	*Fraxinus angustifolia 'Raywood'*	6	0.09	0.09
Gum	*Eucalyptus species*	5	0.08	0.13
Smooth hawthorn	*Crataegus laevigata*	5	0.08	0.03
European white birch	*Betula pendula*	5	0.08	0.06
Almond	*Prunus dulcis*	5	0.08	0.04
Black locust	*Robinia pseudoacacia*	5	0.08	0.08
Japanese persimmon	*Diospyros kaki*	5	0.08	0.07
Peach	*Prunus persica*	5	0.08	0.03
Pine	*Pinus species*	5	0.08	0.05
Xylosma	*Xylosma congestum*	4	0.06	0.04

Common Name	Botanical Name	Number of Trees	% of Pop.	Importance Value
Italian cypress	*Cupressus sempervirens*	4	0.06	0.06
American sycamore	*Platanus occidentalis*	4	0.06	0.15
Red maple	*Acer rubrum*	4	0.06	0.03
Turkish pine	*Pinus brutia*	4	0.06	0.07
Chitalpa	*Chitalpa tashkentensis*	4	0.06	0.03
Mayten tree	*Maytenus boaria*	4	0.06	0.03
Flowering plum	*Prunus X blireiana*	4	0.06	0.03
Jacaranda	*Jacaranda mimosifolia*	4	0.06	0.02
Bigleaf maple	*Acer macrophyllum*	4	0.06	0.05
Saucer magnolia	*Magnolia x soulangiana*	4	0.06	0.03
Mt. Atlas cedar	*Cedrus atlantica*	3	0.05	0.06
Sydney golden wattle	*Acacia longifolia*	3	0.05	0.03
Silk oak	*Grevillea robusta*	3	0.05	0.06
Blue oak	*Quercus douglasii*	3	0.05	0.10
Red gum	*Eucalyptus camaldulensis*	3	0.05	0.10
Modesto ash	*Fraxinus velutina 'Modesto'*	3	0.05	0.06
Red ironbark	*Eucalyptus sideroxylon*	3	0.05	0.03
Italian stone pine	*Pinus pinea*	3	0.05	0.05
Shumard oak	*Quercus shumardii*	3	0.05	0.04
Black stem pittosporum	*Pittosporum tenuifolium*	2	0.03	0.02
Pomegranate	*Punica granatum*	2	0.03	0.01
European beech	*Fagus sylvatica*	2	0.03	0.01
Magnolia	*Magnolia species*	2	0.03	0.01
Japanese black pine	*Pinus thunbergii*	2	0.03	0.01
Japanese loquat	*Eriobotrya japonica*	2	0.03	0.01
Incense cedar	*Calocedrus decurrens*	2	0.03	0.06
Goldenrain tree	*Koelreuteria paniculata*	2	0.03	0.01
Catalina ironwood	*Lyonothamnus floribundus ssp. asplendifolius*	2	0.03	0.02
Indian hawthorn	*Rhaphiolepis*	2	0.03	0.02
Flowering crabapple	*Malus species*	2	0.03	0.01
Japanese flowering crabapple	*Malus floribunda*	2	0.03	0.01
Elm	*Ulmus species*	2	0.03	0.03
Cherry laurel	*Prunus caroliniana*	2	0.03	0.01
Lombardy poplar	*Populus nigra italica*	2	0.03	0.02
Firethorn	*Pyracantha spp.*	1	0.02	0.01
Pecan	*Carya illinoensis*	1	0.02	0.02
Juniper	*Juniperus species*	1	0.02	0.01
Spanish dagger	*Yucca gloriosa*	1	0.02	0.01
Common crabapple	*Malus sylvestris*	1	0.02	0.01
Date palm	*Phoenix dactylifera*	1	0.02	0.01

Common Name	Botanical Name	Number of Trees	% of Pop.	Importance Value
Bunya-bunya tree	*Araucaria bidwillii*	1	0.02	0.05
Arizona cypress	*Cupressus arizonica*	1	0.02	0.02
Toyon	*Heteromeles arbutifolia*	1	0.02	0.01
Chinaberry	*Melia azedarach*	1	0.02	0.01
Mimosa	*Albizia julibrissin*	1	0.02	0.01
Brazilian peppertree	*Schinus terebinthifolius*	1	0.02	0.01
Flame tree	*Koelreuteria bipinnata*	1	0.02	0.01
Canyon live oak	*Quercus chrysolepis*	1	0.02	0.02
Pacific madrone	*Arbutus menziesii*	1	0.02	0.02
Hollywood juniper	*Juniperus Torulosa*	1	0.02	0.01
California privet	*Ligustrum ovalifolium*	1	0.02	0.01
Dawn redwood	*Metasequoia glyptostroboi*	1	0.02	0.02
Little-leaf linden	*Tilia cordata*	1	0.02	0.02
Lemon	*Citrus limon*	1	0.02	0.01
Mexican fan palm	*Washingtonia robusta*	1	0.02	0.01
Aleppo pine	*Pinus halepensis*	1	0.02	0.05
Fremont cottonwood	*Populus fremontii*	1	0.02	0.01
Kwanzan cherry	*Prunus serrulata -Kwanzan-*	1	0.02	0.01
Common fig	*Ficus carica*	1	0.02	0.01
Western sycamore	*Platanus racemosa*	1	0.02	0.02
California wild lilac	*Ceanothus species*	1	0.02	0.01
River she-oak	*Casuarina cunninghamiana*	1	0.02	0.03
Horsetail tree	*Casuarina equisetifolia*	1	0.02	0.02
Pineapple guava	*Feijoa sellowana*	1	0.02	0.01
Oak	*Quercus species*	1	0.02	0.02
Douglas fir	*Pseudotsuga menziesii*	1	0.02	0.03
Port Orford cedar	*Chamaecyparis lawsoniana*	1	0.02	0.01
Desert willow	*Chilopsis linearis*	1	0.02	0.01
Bay laurel	*Laurus nobilis*	1	0.02	0.01
Italian buckthorn	*Rhamnus alaternus*	1	0.02	0.01
Cypress	*Cupressus species*	1	0.02	0.02
California palm	*Washingtonia filifera*	1	0.02	0.01
Total		**6,473**	**100%**	**100.00**