Urban Forest Resource Analysis Manhattan Beach, California 2015

CITY OF MANHATTAN BEACH
SUN SAND SEA
CALIFORNIA

DAVEY RESOURCE GROUP
A Division of The Davey Tree Expert Company

City of Manhattan Beach
Urban Forest Resource Analysis

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EXECUTIVE SUMMARY

Community trees play a critical role in the City of Manhattan Beach, California. They provide numerous benefits both tangible and intangible, to residents, visitors, and neighboring communities. With an inventoried urban forest of 11,575 tree sites, the City's Public Works Department recognizes that public trees are a valued community resource, an important component of the urban infrastructure, and part of the City's identity.

In 2013, to support the preservation and management of community trees, the City commissioned an inventory of public trees on streets, in parks, and at city facilities. The inventory produced a GIS layer that includes vital information about each tree including species, size, condition, and geographic location. The community urban forest includes 4,116 city-maintained trees and 7,459 trees that are maintained by adjacent property owners. In 2015, 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.

Manhattan Beach's community urban forest provides nearly $3.1 million in annual benefits ($88 per capita). These benefits include air quality improvements, energy savings, stormwater runoff reduction, atmospheric CO_2 reduction, and aesthetic contributions to the social and economic health of the community. The annual investment (cost) to maintain the 4,116 city-maintained trees is approximately $515,000. **For every $1 invested in the community urban forest, Manhattan Beach receives $5.99 in benefits.**

Overall, the community urban forest is reducing annual electric energy consumption by 292 MWh and annual natural gas consumption by 2,121 therms, for a combined value of $42,933. In addition, these trees are removing 2.2 tons of pollutants from the air, including ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and particulates (PM_{10}) for an overall annual gross air quality benefit of $121,944. Canopy from this population covers nearly 55 acres. This canopy reduces annual stormwater runoff by more than 3.3 million gallons and protects local water resources by reducing sediment and pollution loading. To date, community trees have sequestered 3,240 tons of CO_2. They continue to sequester an additional 343 tons of CO_2 each year for an annual net benefit valued at $13,397.

The community urban forest in Manhattan Beach is well established and in good condition overall. The resource has a predominance of established young trees, with 58% of trees 6"-12" DBH[1]. With proper management, and planning, the environmental and economic benefits from this resource will continue to increase over time. Regular inspection and proactive maintenance will ensure the preservation of existing benefits, support individual tree longevity, and help manage risk.

Trees are a part of the City's infrastructure. However, unlike most other public assets, with proper maintenance, trees have the potential to increase in value over time. With an established population in good condition, a high percentage of young trees, and more than 182 different species, the community urban forest in Manhattan Beach will continue to be a vital asset to the City and neighboring communities.

[1] DBH. Diameter at breast height, measured at 4'6" above the ground

INTRODUCTION

Manhattan Beach is located 19 miles southwest of Los Angeles on the south end of Santa Monica Bay. Manhattan Beach is proud of its affluent community of about 35,135 residents within 3.88 square miles. Residents enjoy average summer temperatures of 70° F dropping during the winter months to about 55° F. Although the community generally receives around 12 inches of rainfall annually, relatively dry summers can pose an extra challenge to managing the water needs of a diverse urban forest. All trees play a role in supporting a positive and healthy environment. This analysis provides a snapshot of the community urban forest (publicly owned trees) and benchmarks the current structure and benefits of this resource.

Individual trees and a healthy urban forest play an important role in the quality of life and the sustainability of every community. Research demonstrates that healthy 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 a community 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, both public and private, soften the urban hardscape by providing a green sanctuary, making Manhattan Beach a more enjoyable place to live, work, and play. The City's 11,575 community trees play a prominent role in the overall urban forest benefits afforded to the community. The Public Works Department has the responsibility to maintain a portion of the urban forest, which includes 4,116 trees on streets, in parks, and at city facilities. Residents rely on them to protect and maintain this vital resource.

To support the management of the community urban forest, an inventory of public trees was collected in 2013. 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 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 v6.0.9), to develop a resource analysis and report of the existing condition of this urban forest. This report, unique to Manhattan Beach, quantifies the value of the community's trees with regard to 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 communities determine where to focus available resources and set benchmarks for measuring progress.

This analysis describes the structure, function, and value of Manhattan Beach's 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 Manhattan Beach's 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 utility purveyors, non-governmental organizations, air quality districts, federal and state agencies, legislative initiatives, or local assessment fees.
- Benchmark data for developing a long-term urban forest management plan.

SUMMARY

Structure

Manhattan Beach's community urban forest includes 11,575 public trees on streets, in parks, and at city facilities. A structural analysis is the first step towards understanding the benefits provided by these trees as well as their management needs. Considering species composition, diversity, age distribution, condition, canopy coverage, and replacement value, DRG determined that the following information characterizes this urban forest resource:

- More than 182 unique tree species were identified in the inventory. The predominant tree species are queen palm (*Syagrus romanzoffianum*, 9.6%), and cajeput tree (*Melaleuca quinquenervia*, 6.8%).
- 90% of trees are under 12" DBH and over 57% are in the 6 -12" DBH, indicating a young, established population.
- 92% of trees are in good condition.
- Community trees are providing 55 acres of canopy cover, an average of 2.1% of the overall land area in Manhattan Beach.

Replacement of Manhattan Beach's 11,575 community trees with trees of similar size, species, and condition would cost nearly $20.6 million.

- To date, Community trees have sequestered 3,240 tons of carbon, valued at $97,205.
- Replacement of Manhattan Beach's 11,575 community trees with trees of similar size, species, and condition would cost nearly $20.6 million.

Benefits

Annually, Manhattan Beach's community trees provide cumulative benefits to the community at an average value of $266 per tree, for a total gross value of $3.1 million per year. These benefits include:

For every $1 invested in community trees, Manhattan Beach receives $5.99 in benefits.

- Community trees reduce electricity and natural gas use through shading and climate effects for an overall benefit of $42,933, an average of $3.71per tree.
- Each year, community trees sequester a gross 343 tons of atmospheric CO_2 for a net value of $13,397 and an average of $1.16 per tree.
- Net air quality improvements, including removal and avoidance of pollutants, from community trees are valued at $121,944, an average per tree benefit of $10.54.
- Manhattan Beach's community trees intercept nearly 3.3 million gallons of stormwater annually for a total value of $5,989, an average of $0.52 per tree.
- The benefits from Manhattan Beach's community trees to property value, health, aesthetics, and socioeconomics is nearly $2.9 million, an average of $250 per tree.
- When the annual investment of $515,000 for the management of the community urban forest is considered, the annual net benefit (benefits minus investment) for the community is

nearly $2.6 million, an average of $222 per tree. In other words, **for every $1 invested in public trees, the community receives $5.99 in benefits.**

When only city-maintained trees (4,116 trees) are considered, the overall annual benefit from this portion of the community urban forest is $1.3 million. The net benefit is $790,766 ($192/tree). **For every $1 invested in city-maintained trees, the community receives $2.54 in benefits.**

Management

Manhattan Beach's community urban forest is a dynamic resource that requires continued investment to maintain and realize its full benefit potential. **Trees are one of the few community assets that have the potential to increase in value with time and proper management.** Appropriate and timely tree care can substantially increase lifespan. When trees live longer, they provide greater benefits. As individual trees 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.

The urban forest in Manhattan Beach is a young, establishing resource in overall good condition. With continued new tree planting, proactive management, and planning, the benefits from this resource will continue to increase as young trees mature. Young tree training, a regular pruning cycle, and regular inspection to identify structural and age-related defects is recommended to manage risk and reduce the likelihood of tree and branch failure. Based on the resource analysis, DRG recommends the following:

- Maintain a healthy diversity by insuring that new tree plantings include a variety of suitable species and don't unduly increase reliance on prevalent species.
- Provide structural pruning for young trees and regular pruning cycle for all trees.
- Continue to maintain and update the inventory database, including tracking tree growth and condition during regular pruning cycles.

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

MANHATTAN BEACH'S URBAN FOREST RESOURCE

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

Population Composition

Broadleaf evergreen species are common in Manhattan Beach's community urban forest, comprising 54% of the total inventory. Broadleaf trees typically have larger canopies than palm trees of the same diameter size. Since many of the measurable benefits derived from trees are directly related to leaf surface area, broadleaf trees generally provide higher benefit levels than palm trees.

Deciduous broadleaf species make up 11% of the tree population, including 2% large-stature, 5% medium-stature, and 4% small-stature trees. Evergreen broadleaf trees comprise 54% of the population, including 10% large-stature, 19% medium-stature, and 24% small-stature species. Conifers represent 9% of the overall population with predominately large-stature species (7%). Palms comprise 27% including 1% Large, 3% medium, and 23% small.

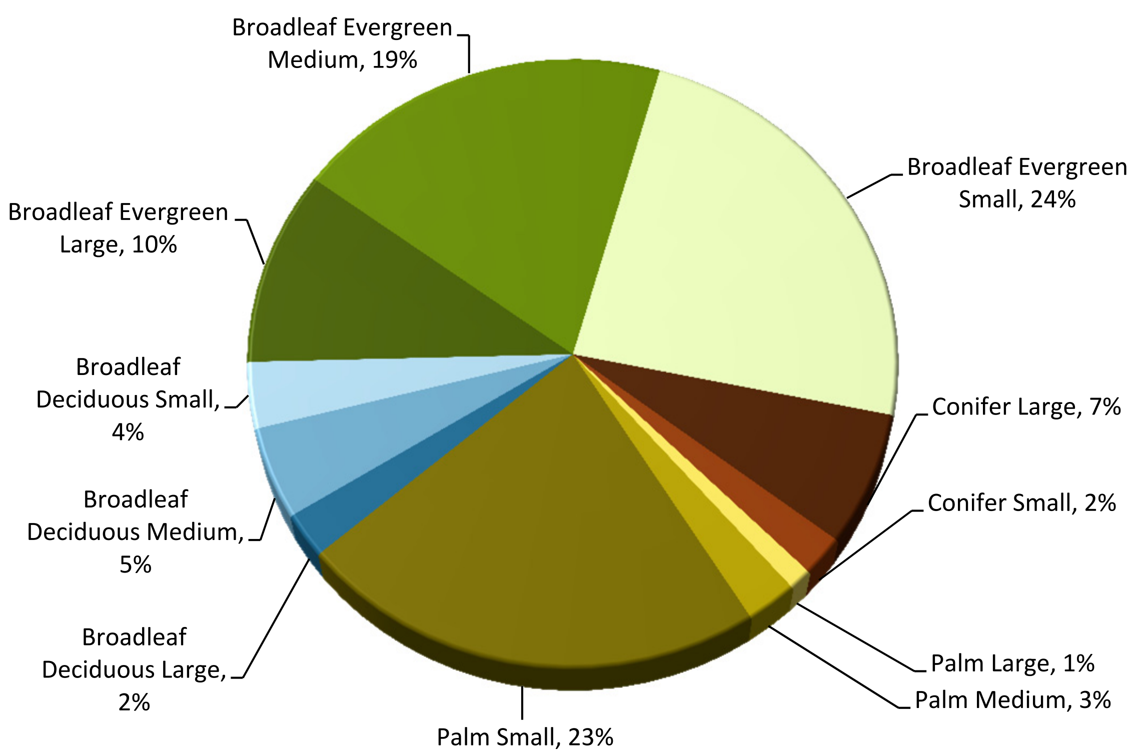


Figure 1. Composition of Tree Type and Stature in Manhattan Beach's Community Urban Forest

Species Richness and Composition

The community tree resource in Manhattan Beach is composed of a wide variety of more than 182 unique species (Table 1 and Appendix C). That's much greater than the mean of 53 species reported by McPherson and Rowntree (1989) in their nationwide survey of street tree populations in 22 U.S. cities.

The top 10 species in Manhattan Beach represent over 46% of the overall population (Figure 2). The predominant tree species are queen palm (*Syagrus romanzoffianum*, 9.58%), and cajeput tree (*Melaleuca quinquenervia*, 6.76%). 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). No genus or species in Manhattan Beach's community urban forest are exceeding these values. The most common genera are *Syagrus* (9.6%), *Melaleuca* (6.8%) and *Eucalyptus* (6.7%).

The tree diversity is adequate in Manhattan Beach. 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 Dutch Elm Disease (*Ophiostoma ulmi*), Emerald Ash Borer (*Agrilus planipennis*), Asian Longhorned Beetle (*Anoplophora glabripennis*), and Sudden Oak Death (SOD) (*Phytophthora ramorum*) are some examples of unexpected, devastating, and costly pests and pathogens that highlight the importance of diversity and the balanced distribution of species and genera.

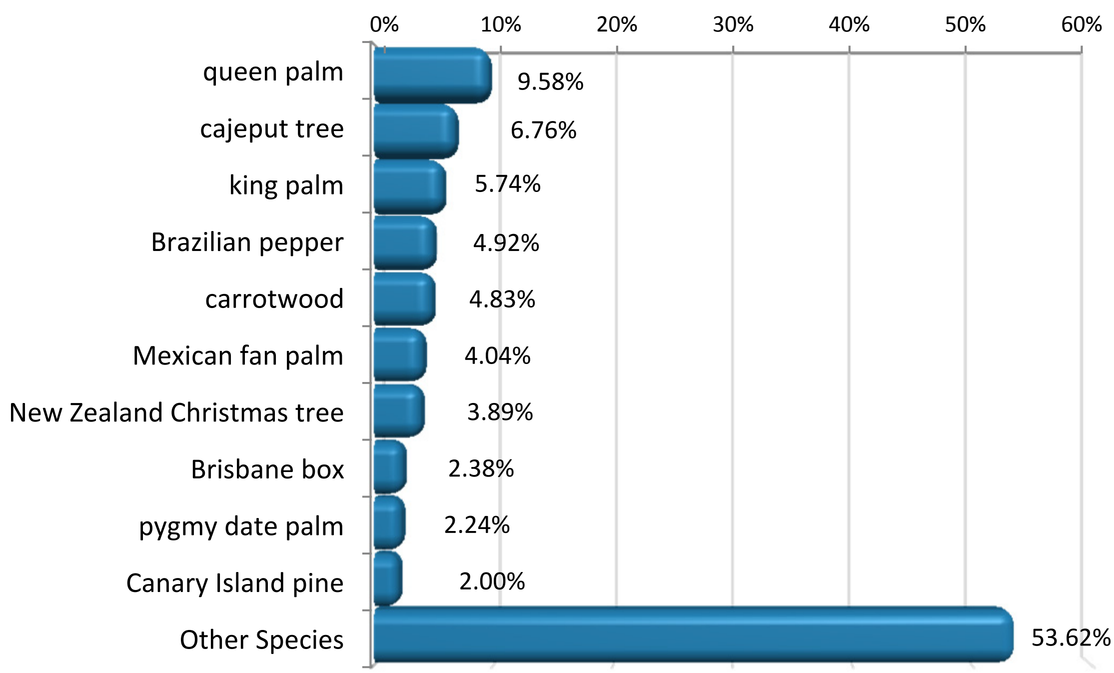


Figure 2. Ten Most Prevalent Species in Manhattan Beach's Community Urban Forest

Table 1. Population Summary of Manhattan Beach's Community Urban Forest (Species representing >1%)

Species	DBH Class (Inches)									Total	% of Pop.
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42		
Broadleaf Deciduous Large (BDL)											
BDL Other	20	71	156	20	5	2	0	0	0	274	2.37%
Total	**20**	**71**	**156**	**20**	**5**	**2**	**0**	**0**	**0**	**274**	**2.37%**
Broadleaf Deciduous Medium (BDM)											
sweetgum	16	33	122	15	0	0	0	0	0	186	1.61%
Callery pear	84	64	24	0	0	0	0	0	0	172	1.49%
BDM Other	39	66	93	2	1	0	0	0	0	201	1.74%
Total	**139**	**163**	**239**	**17**	**1**	**0**	**0**	**0**	**0**	**559**	**4.83%**
Broadleaf Deciduous Small (BDS)											
cherry plum	67	73	24	0	0	0	0	0	0	164	1.42%
BDS Other	90	37	115	1	0	0	0	0	0	243	2.10%
Total	**157**	**110**	**139**	**1**	**0**	**0**	**0**	**0**	**0**	**407**	**3.52%**
Broadleaf Evergreen Large (BEL)											
silver dollar gum	19	29	92	37	10	10	0	0	0	197	1.70%
Chinese elm	3	21	109	3	1	0	0	0	0	137	1.18%
fern pine	9	29	74	9	3	0	0	0	0	124	1.07%
lemon scented gum	4	12	61	32	8	1	0	0	0	118	1.02%
BEL Other	40	46	265	147	72	53	0	0	0	623	5.38%
Total	**75**	**137**	**601**	**228**	**94**	**64**	**0**	**0**	**0**	**1,199**	**10.36%**
Broadleaf Evergreen Medium (BEM)											
cajeput tree	15	104	511	129	16	7	0	0	0	782	6.76%
New Zealand Christmas tree	136	89	214	9	2	0	0	0	0	450	3.89%
weeping fig	15	27	123	4	2	0	0	0	0	171	1.48%
acacia	6	46	105	0	10	0	0	0	0	167	1.44%
southern magnolia	27	8	74	4	0	0	0	0	0	113	0.98%
BEM Other	111	162	263	28	6	4	0	0	0	574	4.96%
Total	**310**	**436**	**1,290**	**174**	**36**	**11**	**0**	**0**	**0**	**2,257**	**19.50%**
Broadleaf Evergreen Small (BES)											
Brazilian pepper	70	145	227	105	22	1	0	0	0	570	4.92%
carrotwood	19	85	446	7	2	0	0	0	0	559	4.83%
Brisbane box	25	55	192	1	2	0	0	0	0	275	2.38%
evergreen pear	16	75	129	4	0	0	0	0	0	224	1.94%
olive	26	35	140	7	1	1	0	0	0	210	1.81%
myoporum	16	75	92	1	1	0	0	0	0	185	1.60%
BES Other	240	192	273	16	3	0	0	0	0	724	6.25%
Total	**412**	**662**	**1,499**	**141**	**31**	**2**	**0**	**0**	**0**	**2,747**	**23.73%**
Conifer Evergreen Large (CEL)											
Canary Island pine	13	8	188	22	1	0	0	0	0	232	2.00%
Aleppo pine	21	10	113	50	31	5	0	0	0	230	1.99%
CEL Other	56	91	145	35	26	2	0	0	0	355	3.07%
Total	**90**	**109**	**446**	**107**	**58**	**7**	**0**	**0**	**0**	**817**	**7.06%**
Conifer Evergreen Small (CES)											
Chinese juniper	4	26	122	2	0	0	0	0	0	154	1.33%
CES Other	7	17	63	4	0	0	0	0	0	91	0.79%
Total	**11**	**43**	**185**	**6**	**0**	**0**	**0**	**0**	**0**	**245**	**2.12%**
Palm Evergreen Large (PEL)											
Canary Island date palm	19	4	33	50	22	0	0	0	0	128	1.11%
PEL Other	1	0	2	0	0	0	0	0	0	3	0.03%
Total	**20**	**4**	**35**	**50**	**22**	**0**	**0**	**0**	**0**	**131**	**1.13%**

Species	DBH Class (Inches)									Total	% of Pop.
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42		
Palm Evergreen Medium (PEM)											
pygmy date palm	52	69	134	4	0	0	0	0	0	259	2.24%
PEM Other	8	11	11	1	0	0	0	0	0	31	0.27%
Total	**60**	**80**	**145**	**5**	**0**	**0**	**0**	**0**	**0**	**290**	**2.51%**
Palm Evergreen Small (PES)											
queen palm	81	90	938	0	0	0	0	0	0	1,109	9.58%
king palm	149	164	351	0	0	0	0	0	0	664	5.74%
Mexican fan palm	17	9	404	38	0	0	0	0	0	468	4.04%
moundlily yucca	15	23	141	8	15	1	0	0	0	203	1.75%
PES Other	40	66	95	1	2	1	0	0	0	205	1.77%
Total	**302**	**352**	**1,929**	**47**	**17**	**2**	**0**	**0**	**0**	**2,649**	**22.89%**
Grand Total	**1,596**	**2,167**	**6,664**	**796**	**264**	**88**	**0**	**0**	**0**	**11,575**	**100%**

Species Importance

To quantify the significance of any one particular species in Manhattan Beach's 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 to 15 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 26 most abundant species (>1%) represent 70% of the overall population, 60% of the total leaf area, and 64% of the total canopy cover for a combined importance value of 64.68 (Table 2). Of these Manhattan Beach relies most on cajeput tree (*Melaleuca quinquenervia*, IV=6.72), carrotwood (*Cupaniopsis anacardioides*, IV=5.82) and Brazilian pepper (*Schinus terebinthifolius*, IV=5.74)

Due to their large stature and high leaf surface area, some species provide more impact than their population numbers alone would suggest. For example, Aleppo pine (*Pinus halepensis*) represents 2% of the population but 5.3% of canopy cover. Canary Island date palm (*Phoenix canariensis*) represents 1% of the population but 4.3% of total canopy cover. These are mature populations of large-stature trees with substantial numbers of established trees.

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, Mexican fan palm (*Washingtonia robusta*) represents 4% of the population but just 1% of canopy cover, and queen palm (*Syagrus romanzoffianum*) represents 9.6% of the population but just 2.6% of canopy cover. While these palms increase in height, they are unlikely to substantially increase in canopy size over time.

Table 2. Importance Value of Manhattan Beach's Most Prevalent Community Tree Species (representing >1%)

Species	Number of Trees	% of Pop.	Leaf Area (ft2)	% of Total Leaf Area	Canopy Cover (ft2)	% of Total Canopy Cover	Importance Value
queen palm	1,109	9.58	117,759	2.06	62,496	2.63	4.76
cajeput tree	782	6.76	427,040	7.48	140,937	5.94	6.72
king palm	664	5.74	51,468	0.90	27,452	1.16	2.60
Brazilian pepper	570	4.92	318,300	5.57	159,841	6.73	5.74
carrotwood	559	4.83	277,476	4.86	184,630	7.78	5.82
Mexican fan palm	468	4.04	57,071	1.00	30,034	1.27	2.10
New Zealand Christmas tree	450	3.89	134,392	2.35	72,279	3.04	3.10
Brisbane box	275	2.38	113,267	1.98	61,701	2.60	2.32
Pygmy date palm	259	2.24	36,419	0.64	28,968	1.22	1.37
Canary Island pine	232	2.00	191,948	3.36	56,711	2.39	2.58
Aleppo pine	230	1.99	367,066	6.43	125,674	5.29	4.57
evergreen pear	224	1.94	91,465	1.60	36,625	1.54	1.69
olive	210	1.81	93,458	1.64	36,533	1.54	1.66
moundlily yucca	203	1.75	24,900	0.44	12,891	0.54	0.91
sliver dollar gum	197	1.70	129,025	2.26	51,233	2.16	2.04
myoporum	186	1.61	154,402	2.70	47,254	1.99	2.10
sweetgum	185	1.60	69,102	1.21	28,042	1.18	1.33
Callery pear	172	1.49	51,322	0.90	17,546	0.74	1.04
weeping fig	171	1.48	109,204	1.91	52,812	2.22	1.87
acacia	167	1.44	114,118	2.00	54,508	2.30	1.91
cherry plum	164	1.42	39,640	0.69	24,559	1.03	1.05
Hollywood juniper	154	1.33	120,942	2.12	27,836	1.17	1.54
Chinese elm	137	1.18	61,029	1.07	24,390	1.03	1.09
Canary Island date palm	128	1.11	123,835	2.17	101,404	4.27	2.52
fern pine	124	1.07	55,331	0.97	21,817	0.92	0.99
lemon scented gum	118	1.02	78,287	1.37	32,394	1.36	1.25
Other trees	3,437	29.69	2,302,504	40.32	853,239	35.94	35.32
All Trees	**11,575**	**100%**	**5,710,768**	**100%**	**2,373,809**	**100%**	**100%**

Canopy Cover

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. The City of Manhattan Beach encompasses an area of 2,496 acres. Overall, community trees provide approximately 54.5 acres of canopy cover, or 2.2% of the city's total area. Considering the 698 acres of street and sidewalk, trees cover 7.8% of those impervious surfaces, increasing the life of pavement surfaces and increasing community walkability. Carrotwood

(*Cupaniopsis anacardioides*) provides the largest portion of canopy, 7.8% (4.2 acres), and Brazilian pepper (*Schinus terebinthifolius*) provide 6.7% (3.7 acres).

The privately-maintained trees contribute 33.75 acres of canopy. This amount is closely proportional to the number of privately-maintained trees, as privately maintained trees are 64.4% of the population and 61.9% of the canopy cover. This canopy calculation does not include private trees in yards or parking lots, so the city's total canopy cover is likely much greater considering all the trees.

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 Manhattan Beach's community urban forest is notably different from the ideal, with 73% of trees between 6-24 inches in diameter (DBH) and <1% of trees larger than 24 inches in diameter (Figure 3). This difference suggests proactive management of this resource should continue with increased tree planting to sustain and increase these benefits over time. The City will need to develop a planting plan to replace aging trees and important species as they reach the end of their lifespan along with increasing the overall stocking rate. Regular inspection and proactive maintenance for mature trees will help to identify structural and age-related defects and manage risk.

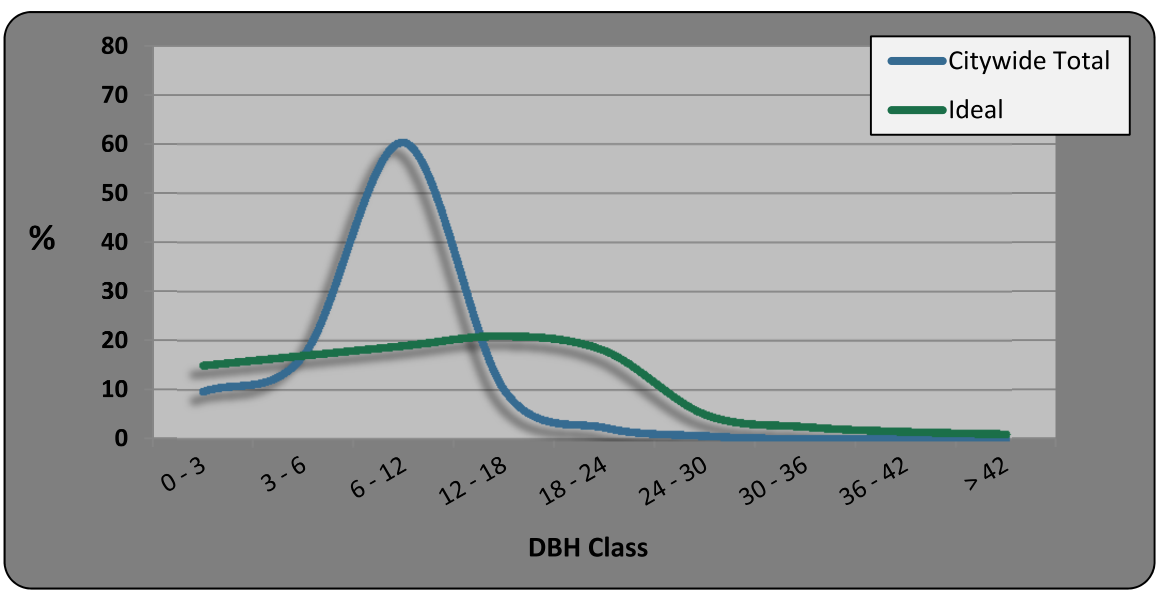
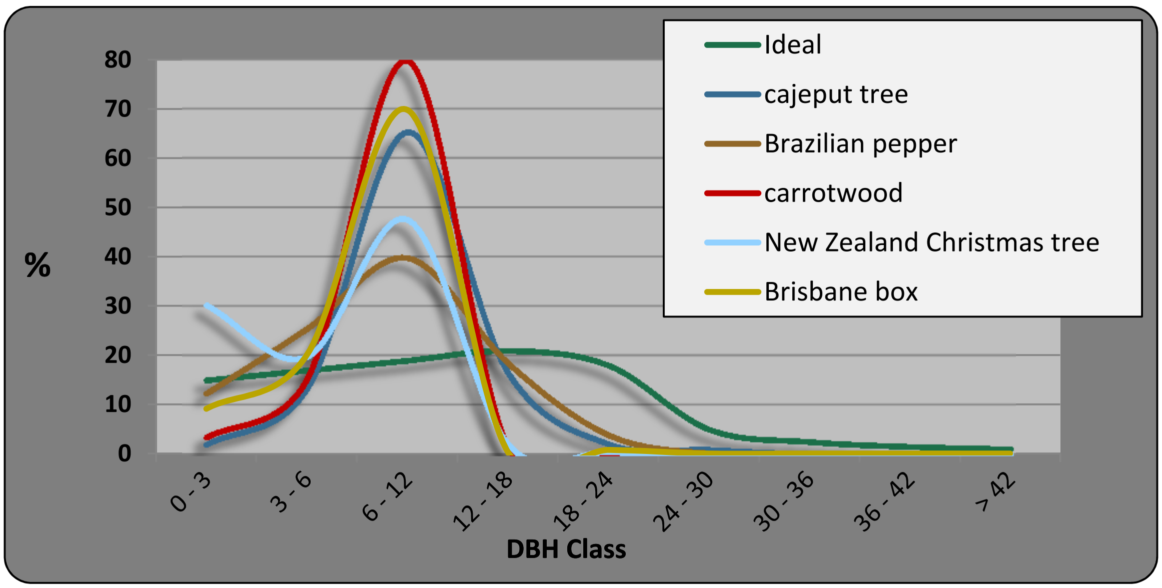


Figure 3. Age Distribution of Manhattan Beach's Community Urban Forest

Of the ten most common species in Manhattan Beach's community urban forest, the youngest population is New Zealand Christmas tree (*Metrosideros excelsus*). Just over 30% of these trees are 3 inches or less in diameter (DBH). This suggests that recent tree plantings have increased the prevalence of this species. Silver dollar gum (*Eucalyptus polyanthemos*) and Aleppo pine (*Pinus halepensis*) are the most mature populations having a small fraction of trees greater than 24 inches in diameter.

All of the ten most common species were found to have >40% of their populations within 6 to 12 inches in DBH. This is an uneven age distribution for non-palm trees in the City's urban forest. As these tree populations mature, and without additional planting efforts, the City could potentially see any one of these tree populations rapidly disappear from the urban forest.



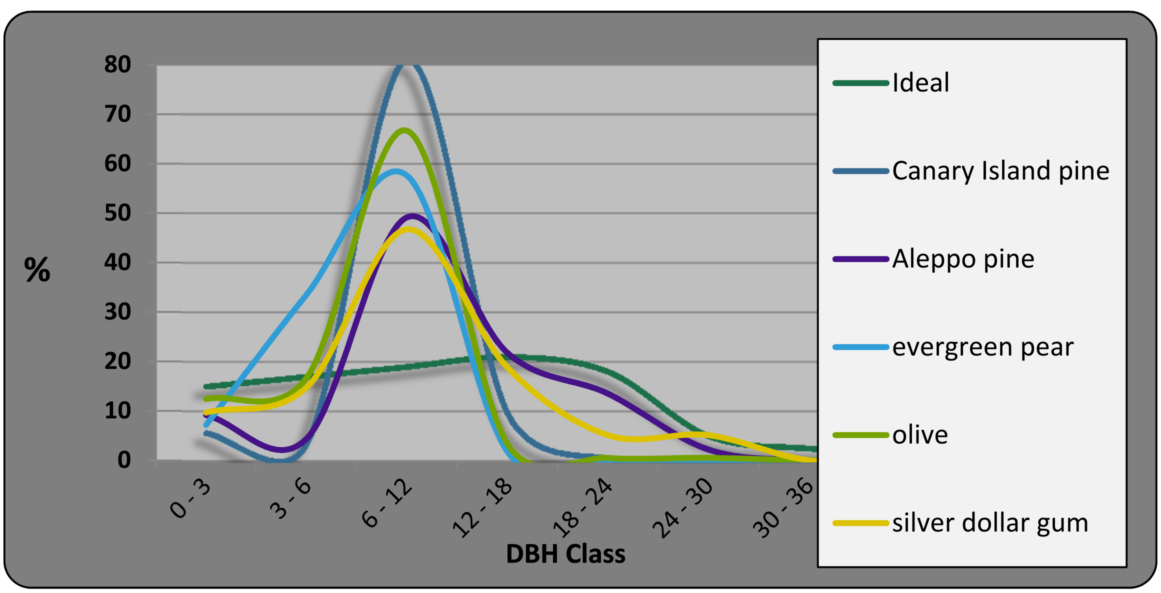


Figure 4. Age Distribution of the Top 10 Tree Species (excluding palm trees)

Urban Forest Condition

Tree condition is an indication of how well trees are managed and how well they are performing in a given site-specific environment (e.g., street, median, parking lot, 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.

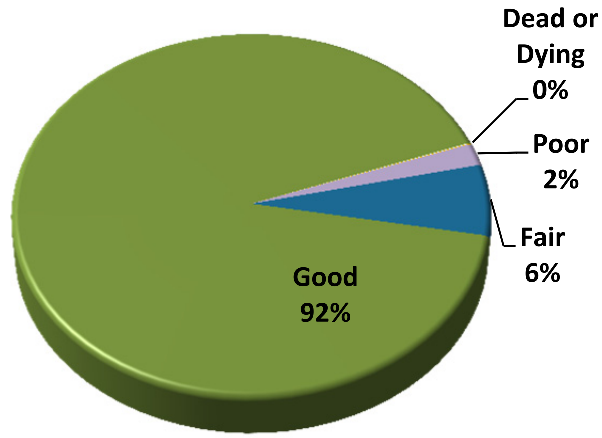


Figure 5. Condition of Manhattan Beach's Community Urban Forest

Manhattan Beach's community forest is overall relatively young and in good condition with 92% good and 6% fair trees (Figure 6). A similar distribution can be seen for trees maintained by residents (94% and 4%, respectively) as well as those cared for by the city (88% and 10%, respectively). About 2% of Manhattan Beach's community trees are poor, dead, or dying; 2.4% for trees managed by the city, 1.9% for trees managed by residents.

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 one species' performance compares to that of another. The index compares the condition ratings of each tree species with the condition ratings of every other tree species within a given urban forest population. An RPI value of 1.0 or better indicates that the species is performing as well or better than average when compared to other species. 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 26 most common species included in this inventory, 21 have an RPI of 1.0 or greater (Table 3). Of these, Mexican fan palm (*Washingtonia robusta*), Chinese juniper (*Juniperus chinensis*), king palm (*Archontophoenix cunninghamiana*), Canary Island date palm (*Phoenix canariensis*), Callery pear (*Pyrus calleryana*), queen palm (*Syagrus romanzoffiana*), cajeput tree (*Melaleuca quinquenervia*), pygmy date palm (*Phoenix roebelenii*), and moundlily yucca (*Yucca gloriosa*) have the highest RPI with 1.03, while myoporum (*Myoporum laetum,* RPI=0.0.80), silver dollar gum (*Eucalyptus polyanthemos*, RPI=0.92), and lemon scented gum (*Eucalyptus citriodora*, RPI=0.94) 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 are encouraged to take into account 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 for Manhattan Beach's Most Prevalent Species (representing >1%)

Species	Dead or Dying	Poor	Fair	Good	N/A	RPI	# of Trees	% of Pop.
queen palm	0.09	0.09	0.99	98.83	0.00	1.03	1,109	9.58
cajeput tree	0.00	0.00	1.53	98.47	0.00	1.03	782	6.76
king palm	0.00	0.15	0.00	99.85	0.00	1.03	664	5.74
Brazilian pepper	0.00	2.81	18.77	78.42	0.00	0.96	570	4.92
carrotwood	0.00	0.18	2.86	96.78	0.18	1.02	559	4.83
Mexican fan palm	0.00	0.00	0.00	100.00	0.00	1.03	468	4.04
New Zealand Christmas tree	0.00	0.44	8.22	91.33	0.00	1.00	450	3.89
Brisbane box	0.00	1.09	3.27	95.64	0.00	1.02	275	2.38
pygmy date palm	0.00	0.00	0.39	99.23	0.39	1.03	259	2.24
Canary Island pine	0.00	0.43	1.72	97.41	0.43	1.02	232	2.00
Aleppo pine	0.43	0.87	1.74	96.96	0.00	1.02	230	1.99
evergreen pear	0.00	0.89	5.36	93.75	0.00	1.01	224	1.94
olive	0.00	1.43	10.48	88.10	0.00	0.99	210	1.81
moundlily yucca	0.00	0.00	0.49	99.01	0.49	1.03	203	1.75
silver dollar gum	0.00	7.11	23.86	69.04	0.00	0.92	197	1.70
sweetgum	0.00	1.61	2.69	95.70	0.00	1.01	186	1.61
myoporum	0.00	18.92	39.46	41.62	0.00	0.80	185	1.60
Callery pear	0.00	0.00	1.16	98.84	0.00	1.03	172	1.49
weeping fig	0.00	1.17	0.58	98.25	0.00	1.02	171	1.48
acacia	0.00	1.80	0.60	97.60	0.00	1.02	167	1.44
cherry plum	0.00	2.44	6.10	91.46	0.00	1.00	164	1.42
Chinese juniper	0.00	0.00	0.00	100.00	0.00	1.03	154	1.33
Chinese elm	0.00	2.19	5.84	91.97	0.00	1.00	137	1.18
Canary Island date palm	0.00	0.00	0.78	99.22	0.00	1.03	128	1.11
fern pine	0.00	1.61	2.42	95.97	0.00	1.02	124	1.07
lemonscented gum	0.00	3.39	23.73	72.88	0.00	0.94	118	1.02
Total	**0.05**	**1.99**	**6.33**	**91.57**	**0.06**	**1.00**	**11,575**	**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. The following species appear to be performing well and should be considered for future tree plantings:

Table 4. Species That May Be Underused (based on RPI and age distribution)

Species	RPI	# of Trees	% of All Trees
Broadleaf Deciduous Large			
California sycamore	1.02	90.00	0.78
Broadleaf Evergreen Large			
ribbon gum eucalyptus	1.03	3.00	0.03
naked coral tree	1.03	11.00	0.10
kaffirboom coral tree	1.03	19.00	0.16
Conifer Large			
Torrey pine	1.03	23.00	0.20
Italian stone pine	1.02	58.00	0.50
Aleppo pine	1.02	230.00	1.99

Replacement Value

The current value of the community urban forest in Manhattan Beach is over $20.6 million (Table 3). The replacement value accounts for the historical investment in trees over their lifetime. The replacement value is also a way of describing the value of a tree population (and/or average value per tree) at a given time. The replacement value reflects current population numbers, stature, 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).

To replace Manhattan Beach's 11,575 community trees with trees of similar size, species, and condition would cost over $20.6 million. The average replacement value per tree is $1,781. Cajeput tree (Melaleuca quinquenervia) and Brazilian pepper (Schinus terebinthifolius) are the most valuable populations representing $4.2 million and 21% of the overall replacement value but just 12% of the overall urban forest resource.

Manhattan Beach's community trees represent a vital component of the City's infrastructure and a public asset valued at over $20.6 million—an asset that, with proper care and maintenance, will continue to increase in value over time. Distinguishing the replacement value from the value of annual benefits produced by this urban forest resource is very important. Annual benefits are examined in Chapter 3.

Table 5. Summary of Replacement Value for Manhattan Beach's Community Urban Forest Resource

Species	DBH Class (in)						Total	% of Value
	0-3	3-6	6-12	12-18	18-24	24-30		
cajeput tree	2,470	81,846	1,500,609	1,036,403	250,642	180,879	3,052,850	14.81
Brazilian pepper	19,402	92,690	407,440	471,811	175,581	15,054	1,181,977	5.73
carrotwood	9,050	62,218	712,080	25,923	13,665	0	822,935	3.99
Aleppo pine	6,597	6,792	212,602	235,905	282,880	75,268	820,044	3.98
New Zealand Christmas tree	22,295	70,544	599,412	72,307	31,330	0	795,889	3.86
Brisbane box	8,784	57,231	637,128	8,949	34,574	0	746,666	3.62
pygmy date palm	25,360	107,341	456,862	16,424	0	0	605,988	2.94
Canary Island pine	1,796	4,970	412,025	131,128	11,593	0	561,512	2.72
silver dollar gum	5,322	15,701	162,909	154,617	86,706	123,971	549,226	2.66
acacia	907	36,120	307,680	0	156,652	0	501,358	2.43
queen palm	14,797	23,777	404,070	0	0	0	442,644	2.15
Canary Island date palm	29,968	8,071	114,385	201,026	88,451	0	441,901	2.14
king palm	31,477	68,531	293,526	0	0	0	393,534	1.91
Indian laurel fig	1,405	16,738	247,550	89,495	12,203	0	367,392	1.78
fern pine	1,482	22,510	214,596	72,307	46,995	0	357,890	1.74
evergreen pear	7,165	61,520	257,565	19,421	0	0	345,671	1.68
lemonscented gum	1,791	10,040	113,028	138,234	59,383	14,747	337,224	1.64
weeping fig	2,190	16,410	270,618	23,841	23,186	0	336,245	1.63
sweetgum	4,472	22,413	230,928	71,056	0	0	328,869	1.59
Itailian stone pine	0	466	22,807	73,795	193,865	27,759	318,691	1.55
Chinese juniper	608	16,154	269,062	11,921	0	0	297,744	1.44
olive	12,104	25,798	215,460	22,655	6,832	11,005	293,854	1.43
redflower gum	2,402	9,342	68,198	105,769	54,617	40,587	280,915	1.36
California sycamore	912	9,320	106,768	81,692	42,961	38,205	279,859	1.36
Chinese elm	850	13,863	202,146	14,495	9,213	0	240,568	1.17
euclayptus, beakpod	0	0	1,756	12,889	116,517	81,174	212,337	1.03
blue gum eucalyptus	0	743	10,601	26,453	61,555	107,049	206,400	1.00
Other Trees	349,991	740,020	3,200,248	657,541	325,766	226,157	5,499,722	26.67
Citywide Total	**$563,596**	**$1,601,168**	**$11,652,060**	**$3,776,058**	**$2,085,168**	**$941,855**	**$20,619,904**	**100%**

BENEFITS FROM MANHATTAN BEACH'S COMMUNITY URBAN FOREST

Trees are important to Manhattan Beach. 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 community trees a good investment for Manhattan Beach? 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 Manhattan Beach's community urban forest. While the annual benefits produced by the urban forest 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 forest where trees are well managed, healthy, and long-lived.

This analysis used current inventory data for Manhattan Beach's community 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.

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 and others, 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 Manhattan Beach from both the shading and climate effects of community trees is equal to 292 MWh (valued at $40,917) and 2,122 therms ($2,016), for a total retail savings of approximately $42,933 and an average of $3.71per tree (Table 4). Publicly-maintained trees, which represent 36% of the population contribute 36% of this benefit for a value of $16,278, while privately-maintained trees provide 62%, $26,655. The species that contribute most to energy benefits on a per-tree basis are large-stature evergreens including dwarf blue gum (*Eucalyptus globulus var compacta*), with an average value of $18.35, and Italian stone pine (*Pinus pinea*) with an average value of $14.40 per tree.

Small-canopy trees are less able to provide electricity and natural gas reduction benefits. On a per-tree basis, queen palm (*Syagrus romanzioffianum)* provides just $1.35 in average benefits, and while the population represents 9.6% of all trees, it is providing just 3.5% of the energy benefits. In fact, small-canopied palms are among the lowest providers of energy benefits. King palm (*Archtonophoenix cunninghamiana*), windmill palm (*Trachycarpus fortunei*), and majestic palm (*Ravenea rivularis*) all have per-tree annual average energy benefits under $2

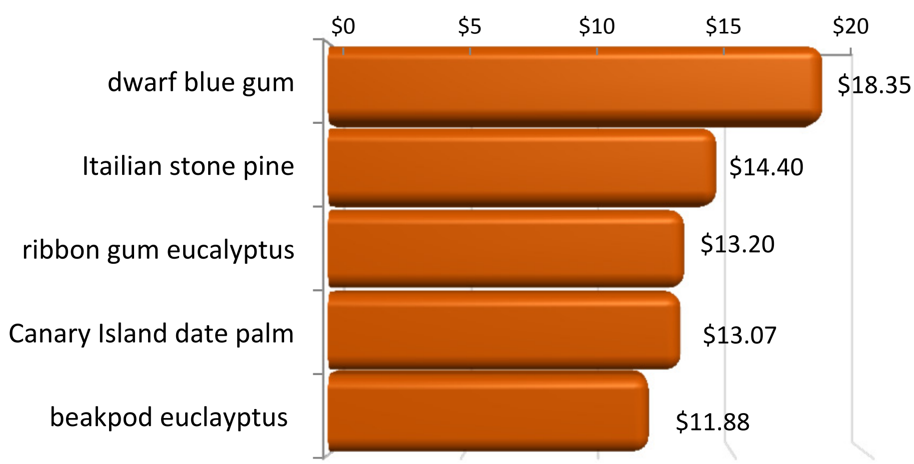


Figure 6. Top Five Species for Per-Tree Annual Electricity and Natural Gas Benefits

Table 6. Annual Electric and Natural Gas Benefits from Manhattan Beach's Community Urban Forest

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	% of Pop.	% of Total $	Avg. $/tree
queen palm	10.25	1,435	61.90	58.80	1,494	9.58	3.48	1.35
cajeput tree	18.80	2,632	168.42	160.00	2,792	6.76	6.50	3.57
king palm	4.38	613	23.83	22.64	636	5.74	1.48	0.96
Brazilian pepper	16.15	2,261	215.31	204.54	2,466	4.92	5.74	4.33
carrotwood	19.28	2,700	294.10	279.39	2,979	4.83	6.94	5.33
Mexican fan palm	4.91	687	34.56	32.84	720	4.04	1.68	1.54
New Zealand Christmas tree	8.65	1,211	71.77	68.18	1,279	3.89	2.98	2.84
Brisbane box	6.72	941	97.36	92.49	1,034	2.38	2.41	3.76
pygmy date palm	3.64	509	42.67	40.54	550	2.24	1.28	2.12
Canary Island pine	9.69	1,357	-1.95	-1.85	1,355	2.00	3.16	5.84
Aleppo pine	16.43	2,300	50.71	48.18	2,348	1.99	5.47	10.21
evergreen pear	4.44	622	17.97	17.07	639	1.94	1.49	2.85
olive	4.46	625	18.50	17.58	643	1.81	1.50	3.06
moundlily yucca	1.99	278	17.19	16.33	295	1.75	0.69	1.45
silver dollar gum	6.10	854	53.45	50.78	904	1.70	2.11	4.59
sweetgum	6.55	917	44.65	42.42	960	1.61	2.24	5.16
myoporum	3.38	473	13.78	13.09	486	1.60	1.13	2.63
Callery pear	2.41	337	8.94	8.49	346	1.49	0.81	2.01
weeping fig	6.19	866	47.16	44.80	911	1.48	2.12	5.33
acacia	6.29	881	47.91	45.51	926	1.44	2.16	5.55
cherry plum	2.66	373	24.50	23.27	396	1.42	0.92	2.42
Chinese juniper	3.52	493	6.21	5.90	499	1.33	1.16	3.24
Chinese elm	2.79	391	29.21	27.75	418	1.18	0.97	3.05
Canary Island date palm	11.41	1,597	79.90	75.91	1,673	1.11	3.90	13.07
fern pine	2.66	373	10.78	10.24	383	1.07	0.89	3.09
lemon scented gum	3.89	545	34.66	32.93	578	1.02	1.35	4.90
Other Trees	104.61	14,646	608.21	577.80	15,224	29.69	35.46	4.43
Total	**292**	**$40,917**	**2,122**	**$2,016**	**$42,933**	**100%**	**100%**	**$3.71**

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)

California's Global Warming Solutions Act (AB 32), passed in 2006, set the 2020 GHG emissions reduction goal into law. In December 2007, the California Air Resources Board (ARB) approved the 2020 emission limit of 427 million metric tons of carbon dioxide equivalent (CO_2e). As of 2007, regulations require that the largest industrial sources of GHG must report and verify their emissions. In 2011, the ARB adopted the cap-and-trade regulation. Under a cap-and-trade system, an upper limit (or cap) is placed on GHG emissions. This cap can be applied to any source, industry, region, or other jurisdictional level (e.g., state, national, global). Regulated entities are required to either reduce emissions to required limits or purchase (trade) emissions offsets in order to meet the cap. In 2011, the ARB approved four offset protocols for issuing carbon credits under cap-and-trade including the Forest Offset Protocol (ARB, 2011). This Protocol recognizes the important role forests play in fighting climate change.

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, campuses, and utility service areas anywhere in the United States.

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

Urban trees reduce atmospheric CO_2 in two ways:

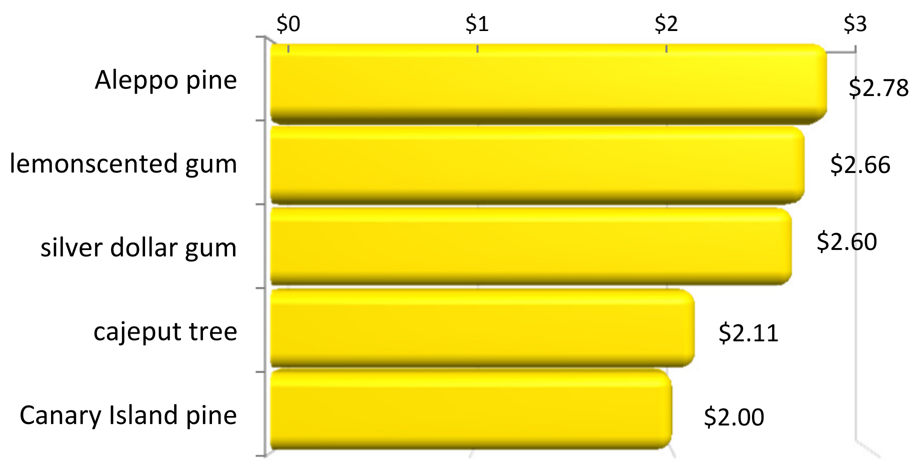
- Directly, through growth and the sequestration of CO_2 in wood, foliar biomass, and soil.
- Indirectly, by lowering the demand for heating and air conditioning, thereby reducing the emissions associated with electric power generation and natural gas consumption.

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. Each of these factors must be considered when calculating the net CO_2 benefits of trees.

Sequestered Carbon Dioxide

To date, community trees in Manhattan Beach have sequestered a total of 3,240 tons of carbon dioxide (CO_2), valued at $97,206[2]. Publicly maintained trees account for 1,162 tons, valued at $34,886, or 36% of the benefit. Annually, all community trees directly sequester an additional 343 tons of CO_2, valued at $10,284, into woody and foliar biomass. Publicly-maintained trees provide 38% of this benefit, for a value of $5,039, and privately-maintained trees provide 62%, $8,358. Accounting for estimated CO_2 emissions from tree decomposition (-34 tons), tree related maintenance activity (-6 tons), and avoided CO_2 (143 tons), Manhattan Beach's community trees provide an annual net reduction in atmospheric CO_2 of 447 tons, valued at $13,397, with an average value of $1.16 per tree (Table 5).

Of prevalent species (representing >1% of the overall resource) Aleppo pine (*Pinus halepensis*, $2.78/tree) and lemon scented gum (*Eucalyptus citriodora*, $2.66/tree) currently provide the highest annual per tree benefit. (Figure 6). The population of cajeput tree (*Melaleuca quinquenervia*) provide the highest amount of annual carbon benefits, valued at $1,653, 12% of the total benefit.



[2] Based on i-Tree *Streets* default value of $0.015/lb, or $30/ton. Market value may vary.

Table 7. Summary of Annual Carbon Benefits from Manhattan Beach's Community Tree Resource

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release(lb)	Maintenance Release (lb)	Total Release ($)	Avoided (lb)	Avoided ($)	Net Total (lb)	Total ($)	% of Pop.	% of Total $	Avg. $/tree
queen palm	33,874	508.11	-6,419	-1,166	-113.78	10,063	150.94	36,352	545	9.58	4.07	0.49
cajeput tree	99,551	1,493.26	-6,823	-981	-117.06	18,460	276.90	110,207	1,653	6.76	12.34	2.11
king palm	20,448	306.73	-2,887	-536	-51.34	4,299	64.49	21,325	320	5.74	2.39	0.48
Brazilian pepper	30,421	456.32	-4,201	-632	-72.50	15,857	237.86	41,445	622	4.92	4.64	1.09
carrotwood	27,645	414.67	-3,458	-593	-60.76	18,933	283.99	42,527	638	4.83	4.76	1.14
Mexican fan palm	14,217	213.26	-3,000	-555	-53.33	4,816	72.23	15,477	232	4.04	1.73	0.50
New Zealand Christmas tree	22,436	336.54	-1,904	-352	-33.84	8,491	127.36	28,671	430	3.89	3.21	0.96
Brisbane box	7,144	107.15	-1,497	-268	-26.47	6,602	99.03	11,981	180	2.38	1.34	0.65
pygmy date palm	4,026	60.38	-679	-212	-13.36	3,573	53.59	6,708	101	2.24	0.75	0.39
Canary Island pine	22,876	343.14	-1,210	-273	-22.25	9,517	142.76	30,910	464	2.00	3.46	2.00
Aleppo pine	29,251	438.76	-2,438	-342	-41.69	16,131	241.96	42,602	639	1.99	4.77	2.78
evergreen pear	2,345	35.17	-616	-206	-12.32	4,359	65.38	5,882	88	1.94	0.66	0.39
olive	2,009	30.14	-654	-207	-12.91	4,383	65.74	5,531	83	1.81	0.62	0.40
moundlily yucca	6,152	92.29	-1,248	-228	-22.14	1,952	29.28	6,629	99	1.75	0.74	0.49
silver dollar gum	30,714	460.71	-2,273	-263	-38.03	5,986	89.79	34,165	512	1.70	3.83	2.60
sweetgum	4,357	65.35	-808	-194	-15.04	6,434	96.51	9,788	147	1.61	1.10	0.79
myoporum	1,955	29.32	-451	-159	-9.14	3,316	49.74	4,661	70	1.60	0.52	0.38
Callery pear	2,558	38.37	-157	-82	-3.59	2,367	35.50	4,685	70	1.49	0.52	0.41
weeping fig	14,760	221.40	-974	-176	-17.25	6,073	91.09	19,683	295	1.48	2.20	1.73
acacia	14,745	221.18	-1,176	-178	-20.31	6,177	92.65	19,568	294	1.44	2.19	1.76
cherry plum	1,781	26.71	-77	-84	-2.41	2,616	39.24	4,236	64	1.42	0.47	0.39
Chinese juniper	5,707	85.61	-392	-163	-8.32	3,458	51.87	8,611	129	1.33	0.96	0.84
Chinese elm	12,201	183.01	-610	-149	-11.38	2,740	41.10	14,182	213	1.18	1.59	1.55
Canary Island date palm	1,768	26.52	-525	-185	-10.65	11,199	167.98	12,257	184	1.11	1.37	1.44
fern pine	1,172	17.58	-384	-129	-7.69	2,613	39.20	3,273	49	1.07	0.37	0.40
lemon scented gum	18,558	278.37	-1,251	-167	-21.26	3,822	57.32	20,962	314	1.02	2.35	2.66
Other Trees	252,930	3,793.94	-21,370	-3,430	-372.01	102,707	1,540.61	330,836	4,963	29.69	37.04	1.44
Citywide Total	**685,600**	**$10,284**	**-67,482**	**-11,908**	**-$1,191**	**286,942**	**$4,304**	**893,152**	**$13,397**	**100%**	**100%**	**$1.16**

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Air Quality Improvement

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 (NO_2) 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 for local residents.

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 and others, 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 net benefit.

Deposition and Interception

Each year, 2.2 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 in Manhattan Beach, for a value of $115,302 (Table 7). As a population, carrotwood (*Cupaniopsis anacardioides*) is the greatest contributor to pollutant deposition and interception, accounting for 8.1% of these 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, 659 pounds of pollutants, valued at $14,304, are avoided annually through the shading effects of Manhattan Beach's community 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 1.1 tons of BVOCs are emitted annually from community trees, offsetting the total air quality benefit by -$7,662. Of prevalent species, the heaviest emitters by population are Mexican fan palm (*Washingtonia robusta*) emitting 14% of BVOCs, and king palm (*Archtonophoenix cunninghamiana*, 13%). The population of sweetgum (*Liquidambar styraciflua*) emit 0.61 pounds of BVOCs annually per tree, and this will increase as these trees mature, as the population is still relatively young with 91% of trees under 12” DBH. While these emissions result in an overall net negative benefit for tulip trees and sweetgum, the positive benefits from all prevalent trees outweigh BVOC emission for an overall positive air quality benefit.

Net Air Quality Improvement

The net value of air pollutants removed by community trees in Manhattan Beach is $121,944 annually. Publicly-maintained trees provide 38% of this benefit, for a value of $46,923, and privately-maintained trees provide 62%, 75,021. The overall average net benefit per tree is $10.54. Trees vary dramatically in their ability to produce air quality benefits. Typically, large-canopied trees with large leaf surface areas that are not high emitters of BVOCs produce the greatest benefits. On a per-tree basis, Canary Island date palm (*Phoenix canariensis*, $42.64) and Aleppo pine (*Pinus halepensis*, $30.81) currently produce the greatest per tree net air quality benefits (Figure 7).

Figure 8. Top 5 Species for Per-Tree Annual Air Quality Benefits

Table 8. Summary of Annual Air Quality Benefits from Manhattan Beach's Community Tree Resource

Species	Deposition O_3 (lb)	Deposition NO_2 (lb)	Deposition PM_{10} (lb)	Deposition SO_2 (lb)	Total Deposition ($)	Avoided NO_2 (lb)	Avoided PM_{10} (lb)	Avoided VOC (lb)	Avoided SO_2 (lb)	Total Avoided ($)	BVOC Emissions (lb)	BVOC Emissions ($)	Total (lb)	Total ($)	% of Pop	Avg. $/tree
queen palm	58.29	27.15	33.68	2.09	3,178	12.76	3.19	1.41	6.09	509	-32.31	-107.92	112.36	3,579	9.58	3.23
cajeput tree	131.46	61.23	75.95	4.71	7,166	23.55	5.81	2.58	11.03	931	-295.01	-985.33	21.31	7,112	6.76	9.09
king palm	25.61	11.93	14.79	0.92	1,396	5.43	1.36	0.60	2.61	217	-14.12	-47.17	49.12	1,566	5.74	2.36
Brazilian pepper	149.09	69.44	86.13	5.34	8,128	20.49	4.97	2.22	9.35	800	-76.58	-255.77	270.45	8,672	4.92	15.21
carrotwood	172.21	80.21	99.49	6.16	9,388	24.95	5.98	2.68	11.22	967	-323.29	-1,079.79	79.61	9,275	4.83	16.59
Mexican fan palm	28.01	13.05	16.18	1.00	1,527	6.14	1.53	0.68	2.91	244	-15.66	-52.30	53.85	1,719	4.04	3.67
New Zealand Christmas tree	67.42	31.40	38.95	2.41	3,675	10.68	2.65	1.18	5.04	424	-100.69	-336.30	59.04	3,763	3.89	8.36
Brisbane box	57.55	26.80	33.25	2.06	3,137	8.65	2.08	0.93	3.91	336	-67.52	-225.52	67.71	3,248	2.38	11.81
pygmy date palm	27.02	12.58	15.61	0.97	1,473	4.63	1.13	0.50	2.13	181	-22.83	-76.26	41.74	1,578	2.24	6.09
Canary Island pine	52.90	24.64	30.56	1.89	2,884	11.43	2.96	1.30	5.71	467	-50.03	-167.10	81.35	3,183	2.00	13.72
Aleppo pine	117.22	54.59	67.72	4.20	6,390	19.65	5.00	2.20	9.60	793	-28.78	-96.12	251.41	7,087	1.99	30.81
evergreen pear	34.16	15.91	19.74	1.22	1,862	5.28	1.34	0.59	2.58	213	0.00	0.00	80.83	2,075	1.94	9.27
olive	34.08	15.87	19.69	1.22	1,858	5.31	1.35	0.60	2.59	214	0.00	0.00	80.71	2,072	1.81	9.87
moundlily yucca	12.02	5.60	6.95	0.43	655	2.52	0.62	0.28	1.18	100	-6.83	-22.82	22.76	732	1.75	3.61
silver dollar gum	47.79	22.26	27.61	1.71	2,605	7.54	1.86	0.83	3.54	298	-103.78	-346.63	9.35	2,557	1.70	12.98
sweetgum	30.46	10.06	15.22	1.21	1,473	8.10	2.02	0.90	3.85	322	-114.10	-381.11	-42.29	1,415	1.61	7.61
myoporum	26.16	12.18	15.11	0.94	1,426	4.02	1.02	0.45	1.96	162	0.00	0.00	61.84	1,588	1.60	8.58
Callery pear	11.31	3.73	5.65	0.45	547	2.92	0.74	0.33	1.43	118	-37.93	-126.68	-11.36	538	1.49	3.13
weeping fig	40.73	15.36	21.63	1.59	2,066	7.62	1.90	0.84	3.61	303	0.00	0.00	93.28	2,370	1.48	13.86
acacia	42.03	15.85	22.33	1.64	2,133	7.75	1.93	0.86	3.67	308	0.00	0.00	96.06	2,441	1.44	14.62
cherry plum	22.91	10.67	13.23	0.82	1,249	3.30	0.82	0.36	1.55	131	0.00	0.00	53.66	1,380	1.42	8.41
Chinese juniper	25.96	12.09	15.00	0.93	1,415	4.11	1.06	0.47	2.04	167	-46.86	-156.52	14.80	1,426	1.33	9.26
Chinese elm	22.75	10.60	13.14	0.81	1,240	3.46	0.85	0.38	1.61	137	-49.09	-163.96	4.52	1,213	1.18	8.85
Canary Island date palm	94.58	44.05	54.64	3.39	5,156	13.94	3.47	1.54	6.61	555	-75.72	-252.89	146.52	5,458	1.11	42.64
fern pine	20.35	9.48	11.76	0.73	1,109	3.17	0.81	0.36	1.55	128	0.00	0.00	48.19	1,237	1.07	9.98
lemon scented gum	30.21	14.07	17.46	1.08	1,647	4.82	1.19	0.53	2.26	191	-62.97	-210.32	8.66	1,628	1.02	13.79
Other Trees	755.07	336.93	428.18	27.52	40,517	127.10	31.95	14.13	61.04	5,087	-769.92	-2,571.52	1,012.00	43,033	29.69	12.52
Citywide Total	**2,137**	**968**	**1,220**	**77.43**	**$115,302**	**359**	**89.61**	**39.72**	**171**	**$14,304**	**-2,294**	**-$7,662**	**2,767**	**$121,944**	**100%**	**$10.54**

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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.

Community trees in Manhattan Beach intercept more than 3.3 million gallons of stormwater annually for an average of 287 gallons per tree (Table 8). The total value of this benefit to the City is $5.989, an average of $0.52 per tree. Publicly-maintained trees provide 39% of this benefit for a value of $2,310, and private trees provide 61%, $3,679. Overall, among prevalent species, Aleppo pine (*Pinus halepensis)* currently provides the greatest per tree benefit of $1.48, followed closely by Cannary Island date palm (*Phoenix canariensis*) $1.46 (Figure 8). The population of cajeput tree (*Melaleuca quinquenervia*) provides the largest portion of stormwater benefit at 6.9%, but this value is aligned with their prevalence in the population as they represent 6.8% of all trees.

As trees grow, their benefits tend to increase, but some species will realize more substantial benefits than others will. Many tree species currently demonstrating lower benefits, including queen palm (*Syagrus romanzofianum*, $0.25/tree), and king palm (*Archtonophoenix cunningamiana*, $0.18/tree) are small-canopy palm trees. As such, their benefits will not increase much over time.

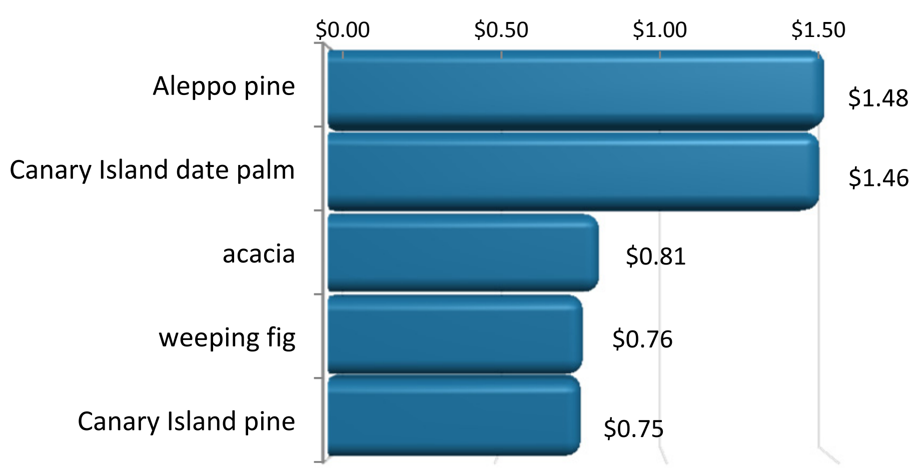

Figure 9. Top 5 Species for Annual Stormwater Benefits

Table 9. Summary of Annual Stormwater Runoff Reduction Benefits from Manhattan Beach's Community Tree Resource

Species	Total Rainfall Interception (Gal)	Total ($)	% of Pop.	% of Total $	Avg. $/tree
queen palm	151,520	273	9.58	4.55	0.25
cajeput tree	228,322	411	6.76	6.86	0.53
king palm	64,925	117	5.74	1.95	0.18
Brazilian pepper	209,555	377	4.92	6.30	0.66
carrotwood	204,370	368	4.83	6.14	0.66
Mexican fan palm	73,611	132	4.04	2.21	0.28
New Zealand Christmas tree	91,307	164	3.89	2.74	0.37
Brisbane box	74,932	135	2.38	2.25	0.49
pygmy date palm	33,158	60	2.24	1.00	0.23
Canary Island pine	96,626	174	2.00	2.90	0.75
Aleppo pine	188,781	340	1.99	5.67	1.48
evergreen pear	52,742	95	1.94	1.59	0.42
olive	53,269	96	1.81	1.60	0.46
moundlily yucca	30,355	55	1.75	0.91	0.27
silver dollar gum	76,334	137	1.70	2.29	0.70
sweetgum	43,099	78	1.61	1.30	0.42
myoporum	40,106	72	1.60	1.21	0.39
Callery pear	15,281	28	1.49	0.46	0.16
weeping fig	71,838	129	1.48	2.16	0.76
acacia	74,696	134	1.44	2.24	0.81
cherry plum	19,866	36	1.42	0.60	0.22
Chinese juniper	51,622	93	1.33	1.55	0.60
Chinese elm	36,240	65	1.18	1.09	0.48
Canary Island date palm	104,001	187	1.11	3.13	1.46
fern pine	31,670	57	1.07	0.95	0.46
lemon scented gum	47,297	85	1.02	1.42	0.72
Other Trees	1,161,892	2091	29.69	34.92	0.61
Citywide Total	**,327,414**	**$5,989**	**100%**	**100%**	**$0.52**

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 Manhattan Beach's community trees associated with property value increases and other less tangible benefits is nearly $2.9 million, an average of $250 per tree (Table 9). Publicly-maintained trees provide 42% of this benefit, valued at $1.3 million, and privately-maintained trees provide 58%, nearly $1.8 million. Overall, among prevalent species, Aleppo pine (*Pinus halepensis*, $770) and Canary Island pine (*Pinus canariensis*, $616) provide the greatest per-tree aesthetic value annually.

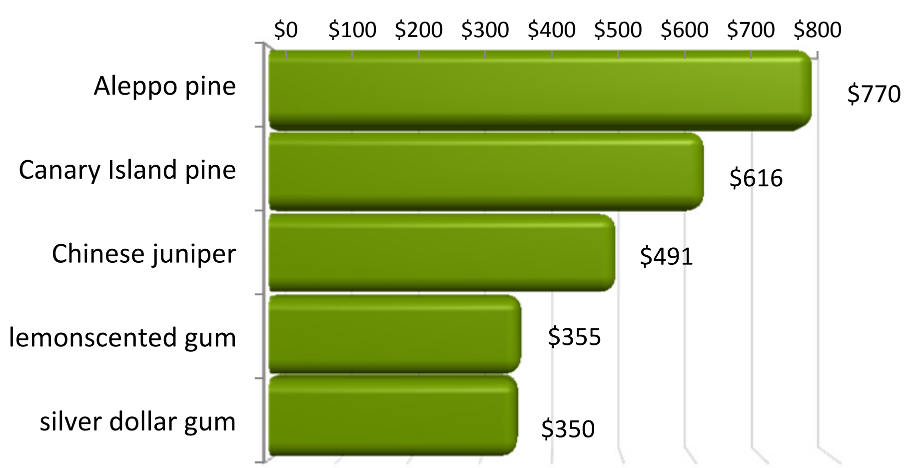

Figure 10. Top 5 Species for Annual Aesthetic Benefits

Table 10. Summary of Annual Aesthetic, Property Value, and Socioeconomic Benefits from Manhattan Beach's Community Tree Resource

Species	Total ($)	% of Pop.	% of Total $	Avg. $/tree
queen palm	112,280	9.58	3.87	101.24
cajeput tree	266,129	6.76	9.18	340.32
king palm	54,977	5.74	1.90	82.80
Brazilian pepper	124,049	4.92	4.28	217.63
carrotwood	104,817	4.83	3.62	187.51
Mexican fan palm	50,433	4.04	1.74	107.76
New Zealand Christmas tree	82,088	3.89	2.83	182.42
Brisbane box	36,910	2.38	1.27	134.22
pygmy date palm	13,455	2.24	0.46	51.95
Canary Island pine	142,982	2.00	4.93	616.30
Aleppo pine	177,111	1.99	6.11	770.05
evergreen pear	17,897	1.94	0.62	79.90
olive	16,133	1.81	0.56	76.82
moundlily yucca	20,701	1.75	0.71	101.98
silver dollar gum	69,018	1.70	2.38	350.35
sweetgum	38,085	1.61	1.31	204.76
myoporum	15,625	1.60	0.54	84.46
Callery pear	44,333	1.49	1.53	257.75
weeping fig	56,087	1.48	1.93	327.99
acacia	55,291	1.44	1.91	331.08
cherry plum	35,502	1.42	1.22	216.48
Chinese juniper	75,544	1.33	2.61	490.54
Chinese elm	37,495	1.18	1.29	273.69
Canary Island date palm	18,457	1.11	0.64	144.19
fern pine	8,839	1.07	0.30	71.28
lemon scented gum	41,922	1.02	1.45	355.27
Other Trees	1,183,319	29.69	40.81	344.29
Citywide Total	**$2,899,478**	**100%**	**100%**	**$250.49**

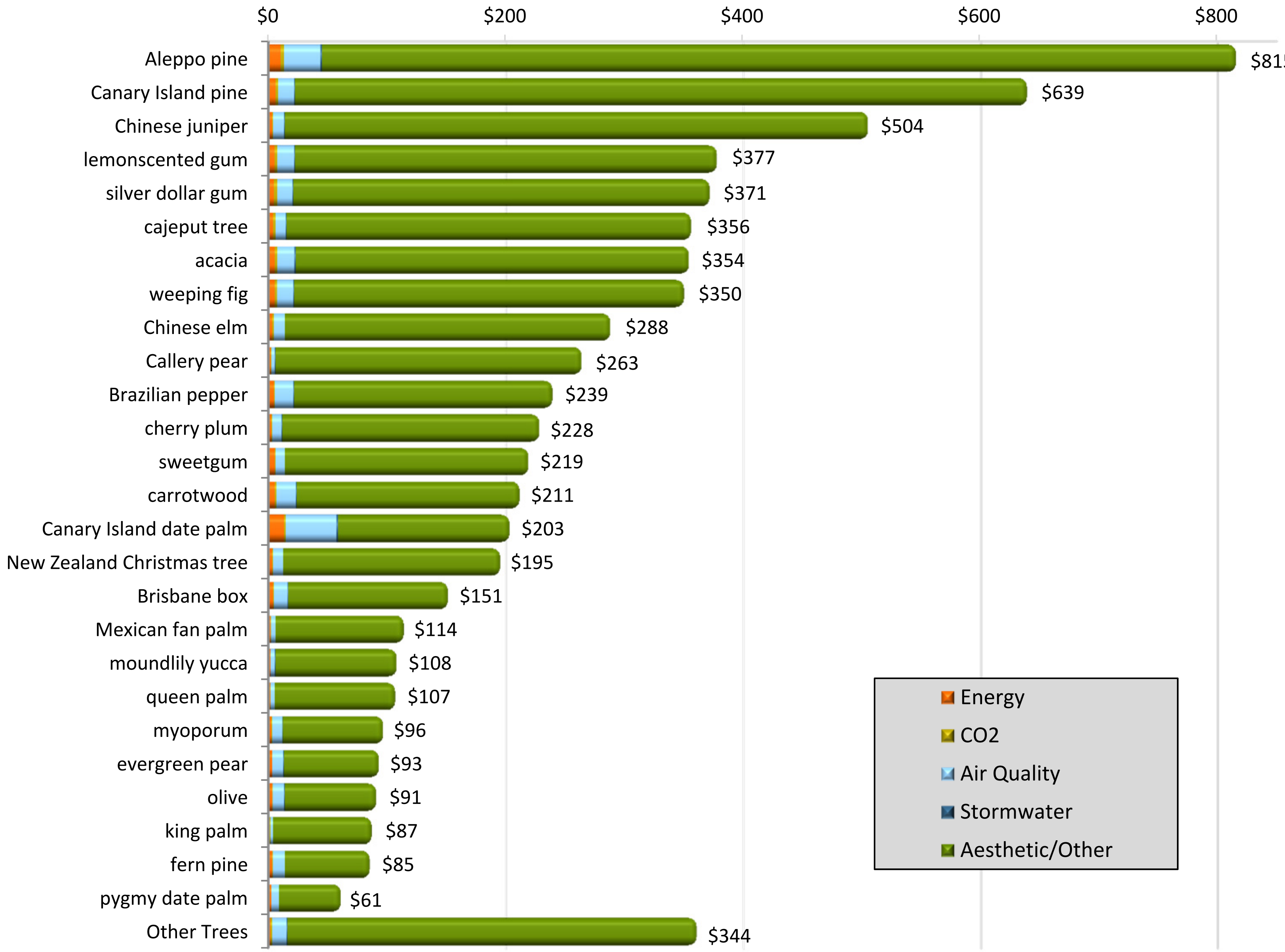

Figure 11. Summary of Annual Per-Tree Benefits from Predominant Species (representing >1%)

Table 11. Summary of Annual per Tree Benefits from Species Representing > 1%

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/ Other	Total
Aleppo pine	10.21	2.78	30.81	1.48	770.05	815.33
Canary Island pine	5.84	2.00	13.72	0.75	616.30	638.61
Chinese juniper	3.24	0.84	9.26	0.60	490.54	504.49
lemon scented gum	4.90	2.66	13.79	0.72	355.27	377.35
silver dollar gum	4.59	2.60	12.98	0.70	350.35	371.21
cajeput tree	3.57	2.11	9.09	0.53	340.32	355.62
acacia	5.55	1.76	14.62	0.81	331.08	353.81
weeping fig	5.33	1.73	13.86	0.76	327.99	349.66
Chinese elm	3.05	1.55	8.85	0.48	273.69	287.62
Callery pear	2.01	0.41	3.13	0.16	257.75	263.46
Brazilian pepper	4.33	1.09	15.21	0.66	217.63	238.92
cherry plum	2.42	0.39	8.41	0.22	216.48	227.91
sweetgum	5.16	0.79	7.61	0.42	204.76	218.73
carrotwood	5.33	1.14	16.59	0.66	187.51	211.23
Canary Island date palm	13.07	1.44	42.64	1.46	144.19	202.80
New Zealand Christmas tree	2.84	0.96	8.36	0.37	182.42	194.94
Brisbane box	3.76	0.65	11.81	0.49	134.22	150.93
Mexican fan palm	1.54	0.50	3.67	0.28	107.76	113.75
moundlily yucca	1.45	0.49	3.61	0.27	101.98	107.79
queen palm	1.35	0.49	3.23	0.25	101.24	106.56
myoporum	2.63	0.38	8.58	0.39	84.46	96.44
evergreen pear	2.85	0.39	9.27	0.42	79.90	92.83
olive	3.06	0.40	9.87	0.46	76.82	90.60
king palm	0.96	0.48	2.36	0.18	82.80	86.77
fern pine	3.09	0.40	9.98	0.46	71.28	85.20
pygmy date palm	2.12	0.39	6.09	0.23	51.95	60.78
Other Trees	1.44	1.44	12.52	0.61	344.29	363.29
Citywide Total	**$3.71**	**$1.16**	**$10.54**	**$0.52**	**$250.49**	**$266.41**

Community Urban Forest - Net Benefits and Benefit versus Investment Ratio (BIR)

Manhattan Beach receives substantial benefits from their community urban forest; however, the City must also consider their investments in maintaining this resource. Applying a *benefit-investment ratio* (BIR) is a useful way to evaluate the public investment in a community tree resource. A BIR is an indicator used to summarize the overall value compared to the investments of a given resource. Specifically, in this analysis, BIR is the ratio of the total value of benefits provided by all the City's community trees compared to the cost (investment) associated with their management.

Manhattan Beach's community urban forest has beneficial effects on the environment. Approximately 6% ($184,264) of the total annual benefits ($3.1 million) from city-maintained trees quantified in this study are environmental services (Table 11). Energy savings ($42,933) account for 23% of the annual environmental benefits and 1% of all benefits. Air quality benefits ($121,944) account for 66% of environmental benefits and 4% of all benefits. Stormwater benefits ($5,989), account for 0.2% of environmental benefits and 3% of all benefits. Carbon reduction ($13,397) accounts for 0.4% of environmental benefits and 7% of all benefits. Annual increases to property value, socioeconomic, and other aesthetic benefits are substantial, accounting for nearly 94% ($2.9 million) of all benefits.

The total estimated benefits provided by Manhattan Beach's city-maintained community urban forest is nearly $3.1 million, a value of $266.41 per tree and $87.77 per capita. These benefits are realized on an annual basis. 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. Tree growth and mortality rates are highly variable. A true and full accounting of benefits and investments must consider variability among sites (e.g., tree species, growing conditions, maintenance practices) throughout the City, as well as variability in tree growth. In other words, **trees are worth far more than what one can ever quantify!**

When the City's annual estimated expenditure (or investment) of $515,000 in this resource is considered, the net annual benefit (benefits minus investment) to the City is $2,568,741. The average net benefit for an individual community tree in Manhattan Beach is $141.29 and the per capita net benefit is $73.11. **Manhattan Beach is currently receiving $5.99 in benefits for every $1 invested in community trees**.

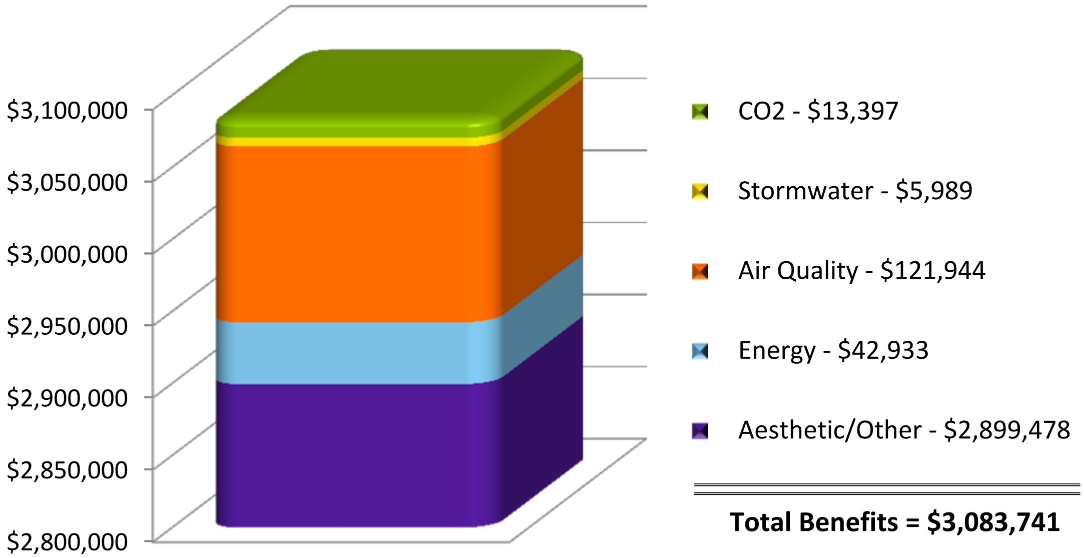

Figure 12. Total Annual Benefits from Community Trees in Manhattan Beach

Total Annual Benefits: $3.1 million

Average Annual per Tree Benefit: $266.41

Annual Value of Benefits per Capita: $87.77

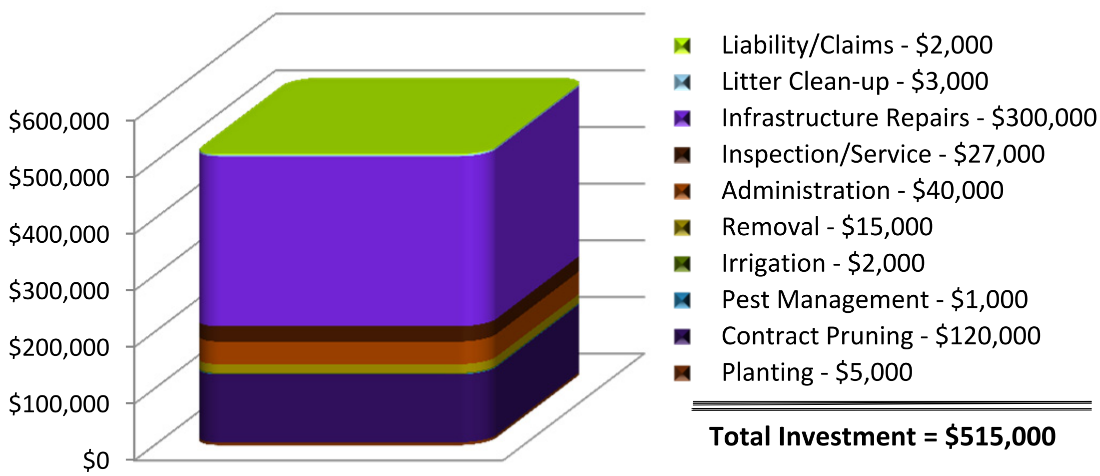

Figure 13. Total Annual Investment to Publicly Maintain Trees in Manhattan Beach

Total Annual Investment: $515,000

Average Annual per Tree Investment: $125.12

Annual Investment per Capita: $14.66

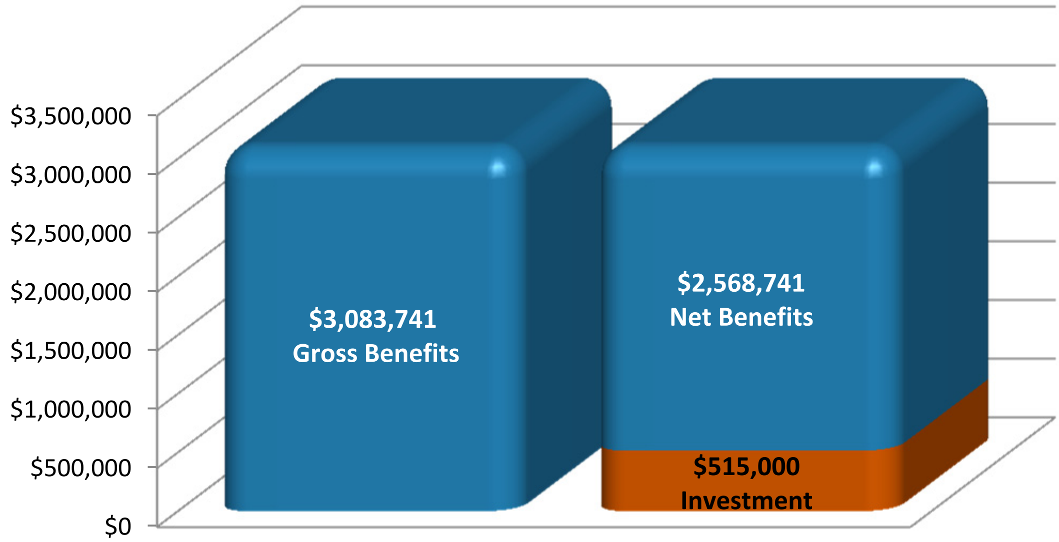

Figure 14. Benefit versus Investment Ratio

Annual Net Benefit of Publicly Maintained Trees in Manhattan Beach: $2.6 million

For EVERY $1 invested in publicly maintained trees, Manhattan Beach receives: $5.99 in benefits

Table 12. Annual Benefit versus Investment Summary for all Community Trees

Benefits	Total ($)	$/tree	$/capita
Energy	42,933	3.71	1.22
CO_2	13,397	1.16	0.38
Air Quality	121,944	10.54	3.47
Stormwater	5,989	0.52	0.17
Aesthetic/Other	2,899,478	250.49	82.52
Total Benefits	**$3,083,741**	**$266.41**	**$87.77**
Investment			
Planting	5,000	0.43	0.14
Contract Pruning	120,000	10.37	3.42
Pest Management	1,000	0.09	0.03
Irrigation	2,000	0.17	0.06
Tree and Stump Removal	15,000	1.30	0.43
Administration	40,000	3.46	1.14
Inspection/Service	27,000	2.33	0.77
Infrastructure Repair	300,000	25.92	8.54
Litter Clean-up	3,000	0.26	0.09
Liability/Claims	2,000	0.71	0.06
Total Investment	**$515,000**	**$44.49**	**$14.66**
Net Benefit	**$2,568,741**	**$221.92**	**$73.11**
Benefit: Investment Ratio			**$5.99**

Publicly Maintained Trees – Net Benefits Consideration

In contrast with the overall net benefits provided by Manhattan Beach's community forest ($2.5M), the trees that are specifically maintained by the City (4,116 trees) provide their own level of benefits that differ from entire community forest. In terms of total benefits, the City maintains a tree population providing just over $1.3 million in benefits, a value of $317.24 per tree and $37.16 per capita. This benefit per tree is $50.33 higher than the overall community benefit ($266.41). This change is a good illustration of how different tree species in a population provide greater benefits than others.

The aesthetic contribution of City maintained trees remains the greatest benefit providing just over $300 per tree, or 95% of the total benefits. This is 17% more than what is provided by the entire community tree population. Air quality benefits were $11.40 per tree and Energy benefits were $3.95 per tree showing an increase (6% and 8%) of the benefits. Carbon reduction and Stormwater benefits remain the lowest at $1.22 per tree for Carbon reduction and $0.56 per tree for Stormwater benefits. Stormwater benefits increase 9% for publicly maintained trees, but carbon reduction benefits increases only 5% compared to the entire community forest.

As expected, since 36% of the urban forest is publicly maintained, the benefit per capita aligns pretty close with proportionate reduction in tree population. Trees that are publicly maintained in Manahattan Beach provide $37.16 per capita, 42% less than the entire population.

Table 13. Net Benefit of Publicly Maintained Trees compared with the Community Forest

Benefits	Total ($)	$/tree	% diff.	$/capita	% diff.
Energy	16,278	3.95	6.21%	0.46	-37.92%
CO_2	5,039	1.22	5.46%	0.14	-37.61%
Air Quality	46,923	11.40	7.59%	1.34	-38.48%
Stormwater	2,310	0.56	7.82%	0.07	-38.58%
Aesthetic/Other	1,235,215	300.10	16.53%	35.16	-42.60%
Total Benefits	**$1,305,766**	**$317.24**	**16.02%**	**$37.16**	**-42.34%**
Total Investment	**$515,000**	**$125.12**		**$14.16**	
Net Benefit	**$790,766**	**$192.12**	**26.46%**	**$22.51**	**-31.78**
Benefit: Investment Ratio	**$2.54**				

CONCLUSION

This analysis describes the current structural characteristics of Manhattan Beach's community urban forest 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 benefits to air quality, reduction in atmospheric CO_2, stormwater runoff reduction, and aesthetic benefits. The City's 11,575 trees are providing over $3.3 million in annual gross benefits. That is an average of $266 per tree and $88 per capita.

The community urban forest in Manhattan Beach is young and establishing and in overall good condition. The resource has a healthy diversity with more than 182 different species. The City 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. Davey Resource Group recommends the following:

- Maintain a healthy diversity by insuring that new tree plantings include a variety of suitable species and don't unduly increase reliance on prevalent species.
- Provide structural pruning for young trees and regular pruning cycle (5-7 years) 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 City's 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, inspiring commitment and providing vision for communication with key decision-makers both inside and outside the organization.

Manhattan Beach's community trees are of vital importance to the environmental, social, and economic well-being of the community. The City has demonstrated that public trees are a valued community resource, a vital component of the urban infrastructure, and an important part of the City's history and 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 as regular maintenance is performed, including updating the DBH and condition of existing trees. Current and complete inventory data will help staff to more efficiently track maintenance activities and tree health and will provide a strong basis for making informed management decisions. A continued commitment to planting, maintaining, and preserving these trees, will support the health and welfare of the City and the surrounding region.

APPENDIX A: METHODOLOGY

In 2013, Certified Arborists collected an inventory of the community trees in Manhattan Beach, 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 6.0.9). 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 Manhattan Beach's community trees, i-Tree *Streets* calculates the dollar value of annual resource functionality. This analysis combines the results of the City's 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 (Manhattan Beach is located in the Southern California Coast Climate Zone).

An annual resource unit was determined on a per tree basis for each of the modeled benefits. Resource units are measured as MWh of electricity saved per tree; MBtu of natural gas conserved per tree; pounds of atmospheric CO_2 reduced per tree; pounds of NO_2,SO_2, O_3, PM_{10}, and VOCs reduced per tree; cubic feet of stormwater runoff reduced per tree; and square feet of leaf area added per tree to increase property values.

Price values assigned to each resource unit (tree) were generated based on economic indicators of society's willingness to pay for the environmental benefits trees provide. The City 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 14. Manhattan Beach Benefit Prices Used In This Analysis

Benefits	Price	Unit	Source
Electricity	0.14	$/Kwh	Southern California Edison (City of Manhattan Beach)
Natural Gas	0.95	$/Therm	Southern California Gas (City of Manhattan Beach)
CO_2	0.01	$/lb	Streets default – Southern California Coast
PM_{10}	9.41	$/lb	Streets default – Southern California Coast
NO_2	12.79	$/lb	Streets default – Southern California Coast
SO_2	3.72	$/lb	Streets default – Southern California Coast
VOC	4.69	$/lb	Streets default – Southern California Coast
Stormwater Interception	0.01	$/gallon	Streets default – Southern California Coast
Median Home Value	2,000,000.00	$	City of Manhattan Beach

i-Tree *Streets* default values (Table 12) from the Southern California Coast 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 the City of Manhattan Beach.

APPENDIX B: REFERENCES

AB 32. 2006. Assembly Bill 32: Global Warming Solutions Act. 2006. *http://www.arb.ca.gov/cc/ab32/ab32.htm*

Air Resources Board. October 2011. Compliance Offset Protocol U.S. Forest Project. California Environmental Protection Agency Air Resources Board. *http://www.arb.ca.gov/regact/2010/capandtrade10/copusforest.pdf*

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 University Press.

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

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

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

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

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

Spare the Air. 2015. Air Quality Index. *http://www.sparetheair.com/aqthisyear.cfm*

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

U.S. Energy Information Administration (EIA) . Web 2014. *<http://www.eia.gov/oiaf/1605/ggccebro/chapter1.html>*

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 15. Complete Population Summary of Tree Species in Manhattan Beach's Community Urban Forest

Species	Botanical Name	DBH Class (Inches)						Total	% of Pop.
		0-3	3-6	6-12	12-18	18-24	24-30		
Broadleaf Deciduous Large (BDL)									
California sycamore	*Platanus racemosa*	6	15	49	14	4	2	90	0.78%
black locust	*Robinia pseudoacacia*	8	26	24	2	1	0	61	0.53%
London planetree	*Platanus hybrida*	0	9	32	3	0	0	44	0.38%
white mulberry	*Morus alba*	4	6	20	0	0	0	30	0.26%
weeping willow	*Salix babylonica*	0	3	13	0	0	0	16	0.14%
willow	*Salix species*	0	6	5	0	0	0	11	0.10%
Carolina poplar	*Populus x canadensis*	0	1	6	0	0	0	7	0.06%
silver maple	*Acer saccharinum*	0	1	2	1	0	0	4	0.03%
maple	*Acer species*	0	1	2	0	0	0	3	0.03%
northern red oak	*Quercus rubra*	1	2	0	0	0	0	3	0.03%
pecan	*Carya illinoensis*	0	1	1	0	0	0	2	0.02%
hackberry	*Celtis species*	0	0	1	0	0	0	1	0.01%
tulip tree	*Liriodendron tulipifera*	1	0	0	0	0	0	1	0.01%
American elm	*Ulmus americana*	0	0	1	0	0	0	1	0.01%
Total		**20**	**71**	**156**	**20**	**5**	**2**	**274**	**2.37%**
Broadleaf Deciduous Medium (BDM)									
sweetgum	*Liquidambar styraciflua*	16	33	122	15	0	0	186	1.61%
Callery pear	*Pyrus calleryana*	84	64	24	0	0	0	172	1.49%
European white birch	*Betula pendula*	7	51	34	1	0	0	93	0.80%
Chinese flame tree	*Koelreuteria bipinnata*	2	11	35	1	1	0	50	0.43%
ginkgo	*Ginkgo biloba*	12	2	1	0	0	0	15	0.13%
tipu	*Tipuana tipu*	4	1	9	0	0	0	14	0.12%
white alder	*Alnus rhombifolia*	0	0	12	0	0	0	12	0.10%
Chinese pistache	*Pistacia chinensis*	9	1	0	0	0	0	10	0.09%
goldenrain tree	*Koelreuteria paniculata*	3	0	0	0	0	0	3	0.03%
Jerusalem thorn	*Parkinsonia aculeata*	0	0	1	0	0	0	1	0.01%
velvet ash	*Fraxinus velutina*	0	0	1	0	0	0	1	0.01%
Desert Museum palo verde	*Parkinsonia X Desert Museum*	1	0	0	0	0	0	1	0.01%

Species	Botanical Name	DBH Class (Inches)						Total	% of Pop.
		0-3	3-6	6-12	12-18	18-24	24-30		
palo verde	*Cercidium species*	1	0	0	0	0	0	1	0.01%
Total		**139**	**163**	**239**	**17**	**1**	**0**	**559**	**4.83%**
Broadleaf Deciduous Small (BDS)									
cherry plum	*Prunus cerasifera*	67	73	24	0	0	0	164	1.42%
jacaranda	*Jacaranda mimosifolia*	6	7	69	1	0	0	83	0.72%
common crapemyrtle	*Lagerstroemia indica*	28	16	26	0	0	0	70	0.60%
eastern redbud	*Cercis canadensis*	20	0	0	0	0	0	20	0.17%
Japanese maple	*Acer palmatum*	10	0	0	0	0	0	10	0.09%
apple	*Malus species*	6	0	2	0	0	0	8	0.07%
Hong Kong orchid tree	*Bauhinia blakeana*	4	1	3	0	0	0	8	0.07%
peach	*Prunus persica*	5	1	2	0	0	0	8	0.07%
common fig	*Ficus carica*	3	4	1	0	0	0	8	0.07%
apricot	*Prunus armeniaca*	2	1	3	0	0	0	6	0.05%
mimosa	*Albizia julibrissin*	1	0	3	0	0	0	4	0.03%
mountain ebony	*Bauhinia variegata*	0	1	2	0	0	0	3	0.03%
pomegranate	*Punica granatum*	0	1	2	0	0	0	3	0.03%
Chinese fringe tree	*Chionanthus retusus*	3	0	0	0	0	0	3	0.03%
mesquite	*Prosopis species*	0	2	0	0	0	0	2	0.02%
saucer magnolia	*Magnolia soulangiana*	0	2	0	0	0	0	2	0.02%
Catalina cherry	*Prunus ilicifolia ssp. lyonii*	0	1	1	0	0	0	2	0.02%
western redbud	*Cercis occidentalis*	1	0	0	0	0	0	1	0.01%
flowering cherry	*Prunus campanulata*	1	0	0	0	0	0	1	0.01%
common plum	*Prunus domestica*	0	0	1	0	0	0	1	0.01%
Total		**157**	**110**	**139**	**1**	**0**	**0**	**407**	**3.52%**
Broadleaf Evergreen Large (BEL)									
silver dollar gum	*Eucalyptus polyanthemos*	19	29	92	37	10	10	197	1.70%
Chinese elm	*Ulmus parvifolia*	3	21	109	3	1	0	137	1.18%
fern pine	*Podocarpus gracilior*	9	29	74	9	3	0	124	1.07%
lemonscented gum	*Eucalyptus citriodora*	4	12	61	32	8	1	118	1.02%
Siberian elm	*Ulmus pumila*	0	1	58	24	2	2	87	0.75%
redflower gum	*Eucalyptus ficifolia*	8	12	28	17	5	2	72	0.62%
spotted gum	*Eucalyptus maculata*	9	7	33	13	5	3	70	0.60%
blue gum eucalyptus	*Eucalyptus globulus*	0	1	10	13	19	22	65	0.56%

Species	Botanical Name	DBH Class (Inches)						Total	% of Pop.
		0-3	3-6	6-12	12-18	18-24	24-30		
shamel ash	*Fraxinus uhdei*	3	3	35	20	3	1	65	0.56%
red ironbark	*Eucalyptus sideroxylon*	6	11	31	9	2	1	60	0.52%
red gum eucalyptus	*Eucalyptus camaldulensis*	5	1	14	13	10	7	50	0.43%
desert gum eucalyptus	*Eucalyptus rudis*	0	3	10	11	7	6	37	0.32%
holly oak	*Quercus ilex*	2	5	21	2	0	0	30	0.26%
kaffirboom coral tree	*Erythrina caffra*	0	0	0	12	4	3	19	0.16%
euclayptus, beakpod	*Eucalyptus robusta*	0	0	1	2	10	4	17	0.15%
silk oak	*Grevillea robusta*	4	1	8	2	1	0	16	0.14%
naked coral tree	*Erythrina coralloides*	0	0	0	7	4	0	11	0.10%
coastal live oak	*Quercus agrifolia*	1	1	9	0	0	0	11	0.10%
Morton Bay fig	*Ficus macrophylla*	1	0	6	1	0	0	8	0.07%
ribbon gum eucalyptus	*Eucalyptus viminalis*	0	0	0	1	0	2	3	0.03%
fig	*Ficus species*	1	0	0	0	0	0	1	0.01%
sugargum	*Eucalyptus cladocalyx*	0	0	1	0	0	0	1	0.01%
Total		**75**	**137**	**601**	**228**	**94**	**64**	**1,199**	**10.36%**
Broadleaf Evergreen Medium (BEM)									
cajeput tree	*Melaleuca quinquenervia*	15	104	511	129	16	7	782	6.76%
New Zealand Christmas tree	*Metrosideros excelsa*	136	89	214	9	2	0	450	3.89%
weeping fig	*Ficus benjamina*	15	27	123	4	2	0	171	1.48%
acacia	*Acacia species*	6	46	105	0	10	0	167	1.44%
southern magnolia	*Magnolia grandiflora*	27	8	74	4	0	0	113	0.98%
California peppertree	*Schinus molle*	15	27	45	2	0	0	89	0.77%
willow-leaved gimlet	*Eucalyptus nicholii*	23	13	29	10	3	4	82	0.71%
camphor tree	*Cinnamomum camphora*	21	8	35	5	1	0	70	0.60%
carob	*Ceratonia siliqua*	1	2	32	10	1	0	46	0.40%
Japanese pittosporum	*Pittosporum tobira*	8	25	12	0	0	0	45	0.39%
brush cherry	*Syzygium paniculatum*	4	17	21	0	0	0	42	0.36%
Sydney golden wattle	*Acacia longifolia*	11	26	5	0	0	0	42	0.36%
unknown	*unknown*	14	2	10	1	0	0	27	0.23%
Victorian box	*Pittosporum undulatum*	2	3	12	0	0	0	17	0.15%

Species	Botanical Name	DBH Class (Inches)						Total	% of Pop.
		0-3	3-6	6-12	12-18	18-24	24-30		
bottle tree	*Brachychiton populneus*	0	4	12	0	0	0	16	0.14%
green acacia	*Acacia decurrens*	1	10	3	0	0	0	14	0.12%
primrose tree	*Lagunaria patersonii*	0	8	6	0	0	0	14	0.12%
mayten	*Maytenus boaria*	2	5	7	0	0	0	14	0.12%
avocado	*Persea americana*	3	3	7	0	0	0	13	0.11%
rubber tree	*Ficus elastica*	1	3	9	0	0	0	13	0.11%
Chinese privet	*Ligustrum lucidum*	3	5	5	0	0	0	13	0.11%
Cape chesnut	*Calodendrum capense*	2	0	6	0	0	0	8	0.07%
Cape cheesewood	*Pittosporum viridiflorum*	0	1	3	0	0	0	4	0.03%
silverleaf stringybark	*Eucalyptus cinerea*	0	0	2	0	0	0	2	0.02%
dwarf blue gum	*Eucalyptus globulus var compacta*	0	0	0	0	1	0	1	0.01%
rusty leaf fig	*Ficus rubiginosa*	0	0	1	0	0	0	1	0.01%
silk floss tree	*Chorisia speciosa*	0	0	1	0	0	0	1	0.01%
Total		**310**	**436**	**1,290**	**174**	**36**	**11**	**2,257**	**19.50%**
Broadleaf Evergreen Small (BES)									
Brazilian pepper	Schinus terebinthifolius	70	145	227	105	22	1	570	4.92%
carrotwood	Cupaniopsis anacardioides	19	85	446	7	2	0	559	4.83%
Brisbane box	Tristaniopsis conferta	25	55	192	1	2	0	275	2.38%
evergreen pear	Pyrus kawakamii	16	75	129	4	0	0	224	1.94%
olive	Olea europaea	26	35	140	7	1	1	210	1.81%
myoporum	Myoporum laetum	16	75	92	1	1	0	185	1.60%
Indian laurel fig	Ficus microcarpa Nitida	4	16	73	10	1	0	104	0.90%
lemon bottlebrush	Callistemon citrinus	23	39	38	0	0	0	100	0.86%
yew podocarpus	Podocarpus macrophyllus	48	4	4	0	0	0	56	0.48%
strawberry tree	Arbutus unedo	31	14	9	0	0	0	54	0.47%
lemon	Citrus limon	26	13	12	0	0	0	51	0.44%
orange	Citrus sinensis	28	9	5	0	0	0	42	0.36%
Australian willow	Geijera parviflora	16	6	15	0	0	0	37	0.32%
oleander	Nerium oleander	4	18	11	0	0	0	33	0.29%
giant bird of paradise	Strelitzia nicolai	0	4	15	5	1	0	25	0.22%
weeping bottlebrush	Callistemon viminalis	4	10	9	0	0	0	23	0.20%
peppermint tree	Agonis flexuosa	2	4	16	0	0	0	22	0.19%
gold medallion tree	Cassia leptophylla	12	6	4	0	0	0	22	0.19%

Species	Botanical Name	DBH Class (Inches)						Total	% of Pop.
		0-3	3-6	6-12	12-18	18-24	24-30		
Carolina laurelcherry	Prunus caroliniana	5	7	4	1	1	0	18	0.16%
loquat	Eriobotrya japonica	8	1	8	0	0	0	17	0.15%
bronze loquat	Eriobotrya deflexa	2	5	8	0	0	0	15	0.13%
Florida hopbush	Dodonaea viscosa	4	6	4	0	0	0	14	0.12%
Green Gem Indian laurel fig	Ficus microcarpa nitida var green gem	0	0	14	0	0	0	14	0.12%
African sumac	Rhus lancea	7	3	2	0	0	0	12	0.10%
pink trumpet tree	Tabebuia impetiginosa	9	2	0	0	0	0	11	0.10%
pink melaleuca	Melaleuca nesophila	0	8	0	0	0	0	8	0.07%
Wilson holly	Ilex altaclarensis	0	3	4	0	0	0	7	0.06%
Australian tea tree	Leptospermum laevigatum	0	2	4	0	0	0	6	0.05%
shiny xylosma	Xylosma congestum	0	1	5	0	0	0	6	0.05%
sweetshade	Hymenosporum flavum	4	1	0	0	0	0	5	0.04%
Chinese holly	Ilex cornuta	0	0	2	0	0	0	2	0.02%
yellow oleander	Thevetia peruviana	0	2	0	0	0	0	2	0.02%
Indian hawthorne	Rhaphiolepis Majestic Beauty	1	1	0	0	0	0	2	0.02%
pineapple guava	Feijoa sellowiana	0	2	0	0	0	0	2	0.02%
Chinese hibiscus	Hibiscus rosa-sinensis	0	1	1	0	0	0	2	0.02%
macadamia	Macadamia integrifolia	0	0	1	0	0	0	1	0.01%
Mexican shrubby spurge	Euphorbia cotinifolia	0	0	1	0	0	0	1	0.01%
cockspur coral tree	Erythrina crista-galli	0	0	1	0	0	0	1	0.01%
Mexican blue fig	Ficus petiolaris	0	0	1	0	0	0	1	0.01%
tupidanthus	Tupidanthus calyptratus	0	1	0	0	0	0	1	0.01%
grapefruit	Citrus X paradisi	0	1	0	0	0	0	1	0.01%
tangerine	Citrus reticulata	1	0	0	0	0	0	1	0.01%
dombeya	Dombeya wallichii	0	1	0	0	0	0	1	0.01%
kaffir plum	Harpephyllum caffrum	0	0	1	0	0	0	1	0.01%
long-leafed yellowwood	Podocarpus henkelii	0	0	1	0	0	0	1	0.01%
sugar bush	Rhus ovata	0	1	0	0	0	0	1	0.01%
Minneola tangelo	Citrus X Tangelo	1	0	0	0	0	0	1	0.01%
Total		**412**	**662**	**1,499**	**141**	**31**	**2**	**2,747**	**23.73%**

Species	Botanical Name	DBH Class (Inches)						Total	% of Pop.
		0-3	3-6	6-12	12-18	18-24	24-30		
Conifer Evergreen Large (CEL)									
Canary Island pine	*Pinus canariensis*	13	8	188	22	1	0	232	2.00%
Aleppo pine	*Pinus halepensis*	21	10	113	50	31	5	230	1.99%
Montery pine	*Pinus radiata*	7	15	64	9	1	0	96	0.83%
Italian cypress	*Cupressus sempervirens*	12	61	16	1	0	0	90	0.78%
Itailian stone pine	*Pinus pinea*	0	1	15	17	23	2	58	0.50%
araucaria	*Araucaria species*	8	8	20	0	0	0	36	0.31%
Torrey pine	*Pinus torreyana*	11	1	4	5	2	0	23	0.20%
incense cedar	*Calocedrus decurrens*	0	2	14	0	0	0	16	0.14%
coast redwood	*Sequoia sempervirens*	7	3	1	1	0	0	12	0.10%
Afghan pine	*Pinus elderica*	4	0	4	1	0	0	9	0.08%
deodar cedar	*Cedrus deodara*	4	0	1	1	0	0	6	0.05%
river she-oak	*Casuarina cunninghamiana*	0	0	4	0	0	0	4	0.03%
pine	*Pinus species*	3	0	0	0	0	0	3	0.03%
coast beefwood	*Casuarina stricta*	0	0	1	0	0	0	1	0.01%
jelecote pine	*Pinus patula*	0	0	1	0	0	0	1	0.01%
Total		**90**	**109**	**446**	**107**	**58**	**7**	**817**	**7.06%**
Conifer Evergreen Small (CES)									
Chinese juniper	*Juniperus chinensis*	4	26	122	2	0	0	154	1.33%
Japanese black pine	*Pinus thunbergiana*	7	14	41	2	0	0	64	0.55%
Leyland cypress	*x Cupressocyparis leylandii*	0	0	22	2	0	0	24	0.21%
Oriental arborvitae	*Platycladus orientalis*	0	2	0	0	0	0	2	0.02%
juniper	*Juniperus species*	0	1	0	0	0	0	1	0.01%
Total		**11**	**43**	**185**	**6**	**0**	**0**	**245**	**2.12%**
Palm Evergreen Large (PEL)									
Canary Island date palm	*Phoenix canariensis*	19	4	33	50	22	0	128	1.11%
palm	*Palm spp.*	1	0	2	0	0	0	3	0.03%
Total		**20**	**4**	**35**	**50**	**22**	**0**	**131**	**1.13%**
Palm Evergreen Medium (PEM)									
pygmy date palm	*Phoenix roebelenii*	52	69	134	4	0	0	259	2.24%
paradise palm	*Howea forsteriana*	8	11	1	0	0	0	20	0.17%
date palm	*Phoenix dactylifera*	0	0	10	1	0	0	11	0.10%
Total		**60**	**80**	**145**	**5**	**0**	**0**	**290**	**2.51%**

Species	Botanical Name	DBH Class (Inches)						Total	% of Pop.
		0-3	3-6	6-12	12-18	18-24	24-30		
Palm Evergreen Small (PES)									
queen palm	*Syagrus romanzoffianum*	81	90	938	0	0	0	1,109	9.58%
king palm	*Archontophoenix cunninghamiana*	149	164	351	0	0	0	664	5.74%
Mexican fan palm	*Washingtonia robusta*	17	9	404	38	0	0	468	4.04%
moundlily yucca	*Yucca gloriosa*	15	23	141	8	15	1	203	1.75%
windmill palm	*Trachycarpus fortunei*	29	42	26	0	0	0	97	0.84%
mediterranean fan palm	*Chamaerops humilis*	3	16	49	0	0	0	68	0.59%
dragon tree	*Dracaena draco*	2	4	4	0	0	0	10	0.09%
poneytail palm	*Nolina species*	0	3	4	1	0	0	8	0.07%
Guadalupe palm	*Brahea edulis*	1	0	5	0	0	0	6	0.05%
triangle palm	*Dypsis decaryi*	0	0	4	0	0	0	4	0.03%
yucca	*Yucca species*	0	1	3	0	0	0	4	0.03%
California palm	*Washingtonia filifera*	0	0	0	0	2	1	3	0.03%
majestic palm	*Ravenea rivularis*	3	0	0	0	0	0	3	0.03%
Chilean wine palm	*Jubaea chilensis*	2	0	0	0	0	0	2	0.02%
Total		**302**	**352**	**1,929**	**47**	**17**	**2**	**2,649**	**22.89%**
Grand Total		**1,596**	**2,167**	**6,664**	**796**	**264**	**88**	**11,575**	**100%**

Table 16. Relative Performance of All Species

Species	Dead or Dying	Poor	Fair	Good	N/A	RPI	# of Trees	% of Pop.
queen palm	0.09	0.09	0.99	98.83	0.00	1.03	1,109	9.58
cajeput tree	0.00	0.00	1.53	98.47	0.00	1.03	782	6.76
king palm	0.00	0.15	0.00	99.85	0.00	1.03	664	5.74
Brazilian pepper	0.00	2.81	18.77	78.42	0.00	0.96	570	4.92
carrotwood	0.00	0.18	2.86	96.78	0.18	1.02	559	4.83
Mexican fan palm	0.00	0.00	0.00	100.00	0.00	1.03	468	4.04
New Zealand Christmas tree	0.00	0.44	8.22	91.33	0.00	1.00	450	3.89
Brisbane box	0.00	1.09	3.27	95.64	0.00	1.02	275	2.38
pygmy date palm	0.00	0.00	0.39	99.23	0.39	1.03	259	2.24
Canary Island pine	0.00	0.43	1.72	97.41	0.43	1.02	232	2.00
Aleppo pine	0.43	0.87	1.74	96.96	0.00	1.02	230	1.99
evergreen pear	0.00	0.89	5.36	93.75	0.00	1.01	224	1.94
olive	0.00	1.43	10.48	88.10	0.00	0.99	210	1.81
moundlily yucca	0.00	0.00	0.49	99.01	0.49	1.03	203	1.75

Species	Dead or Dying	Poor	Fair	Good	N/A	RPI	# of Trees	% of Pop.
silver dollar gum	0.00	7.11	23.86	69.04	0.00	0.92	197	1.70
sweetgum	0.00	1.61	2.69	95.70	0.00	1.01	186	1.61
myoporum	0.00	18.92	39.46	41.62	0.00	0.80	185	1.60
Callery pear	0.00	0.00	1.16	98.84	0.00	1.03	172	1.49
weeping fig	0.00	1.17	0.58	98.25	0.00	1.02	171	1.48
acacia	0.00	1.80	0.60	97.60	0.00	1.02	167	1.44
cherry plum	0.00	2.44	6.10	91.46	0.00	1.00	164	1.42
Chinese juniper	0.00	0.00	0.00	100.00	0.00	1.03	154	1.33
Chinese elm	0.00	2.19	5.84	91.97	0.00	1.00	137	1.18
Canary Island date palm	0.00	0.00	0.78	99.22	0.00	1.03	128	1.11
fern pine	0.00	1.61	2.42	95.97	0.00	1.02	124	1.07
lemon scented gum	0.00	3.39	23.73	72.88	0.00	0.94	118	1.02
southern magnolia	0.00	8.85	16.81	74.34	0.00	0.93	113	0.98
Indian laurel fig	0.00	0.00	0.96	99.04	0.00	1.03	104	0.90
lemon bottlebrush	0.00	0.00	3.00	97.00	0.00	1.02	100	0.86
windmill palm	0.00	1.03	0.00	98.97	0.00	1.03	97	0.84
Montery pine	2.08	10.42	17.71	69.79	0.00	0.90	96	0.83
European white birch	0.00	2.15	7.53	90.32	0.00	1.00	93	0.80
California sycamore	0.00	0.00	4.44	95.56	0.00	1.02	90	0.78
Italian cypress	0.00	0.00	0.00	100.00	0.00	1.03	90	0.78
California peppertree	0.00	3.37	5.62	88.76	2.25	0.97	89	0.77
Siberian elm	0.00	24.14	72.41	3.45	0.00	0.67	87	0.75
jacaranda	0.00	2.41	4.82	92.77	0.00	1.00	83	0.72
willow-leaved gimlet	0.00	0.00	18.29	81.71	0.00	0.98	82	0.71
redflower gum	0.00	2.78	8.33	88.89	0.00	0.99	72	0.62
camphor tree	0.00	5.71	25.71	68.57	0.00	0.92	70	0.60
common crapemyrtle	0.00	0.00	0.00	100.00	0.00	1.03	70	0.60
spotted gum	0.00	1.43	20.00	78.57	0.00	0.96	70	0.60
mediterranean fan palm	0.00	0.00	0.00	100.00	0.00	1.03	68	0.59
blue gum eucalyptus	0.00	4.62	6.15	89.23	0.00	0.99	65	0.56
shamel ash	0.00	13.85	23.08	63.08	0.00	0.88	65	0.56
Japanese black pine	0.00	0.00	4.69	95.31	0.00	1.02	64	0.55
black locust	0.00	1.64	13.11	85.25	0.00	0.98	61	0.53
red ironbark	0.00	0.00	15.00	85.00	0.00	0.99	60	0.52
Itailian stone pine	1.72	0.00	0.00	98.28	0.00	1.02	58	0.50
yew podocarpus	0.00	0.00	0.00	100.00	0.00	1.03	56	0.48
strawberry tree	0.00	5.56	1.85	92.59	0.00	0.99	54	0.47
lemon	0.00	0.00	0.00	100.00	0.00	1.03	51	0.44
Chinese flame tree	0.00	0.00	6.00	94.00	0.00	1.01	50	0.43
red gum eucalyptus	0.00	6.00	18.00	76.00	0.00	0.94	50	0.43
carob	0.00	13.04	21.74	65.22	0.00	0.89	46	0.40

Species	Dead or Dying	Poor	Fair	Good	N/A	RPI	# of Trees	% of Pop.
Japanese pittosporum	0.00	0.00	4.44	95.56	0.00	1.02	45	0.39
London planetree	0.00	0.00	11.36	88.64	0.00	1.00	44	0.38
brush cherry	0.00	0.00	14.29	85.71	0.00	0.99	42	0.36
orange	0.00	0.00	0.00	100.00	0.00	1.03	42	0.36
Sydney golden wattle	0.00	0.00	19.05	80.95	0.00	0.97	42	0.36
Australian willow	0.00	2.70	0.00	97.30	0.00	1.02	37	0.32
desert gum eucalyptus	0.00	51.35	24.32	24.32	0.00	0.65	37	0.32
araucaria	0.00	0.00	2.78	97.22	0.00	1.02	36	0.31
oleander	0.00	0.00	0.00	100.00	0.00	1.03	33	0.29
holly oak	0.00	3.33	6.67	90.00	0.00	0.99	30	0.26
white mulberry	0.00	0.00	0.00	100.00	0.00	1.03	30	0.26
unknown	3.70	7.41	0.00	88.89	0.00	0.95	27	0.23
giant bird of paradise	0.00	0.00	0.00	100.00	0.00	1.03	25	0.22
Leyland cypress	0.00	0.00	0.00	100.00	0.00	1.03	24	0.21
Torrey pine	0.00	0.00	0.00	100.00	0.00	1.03	23	0.20
weeping bottlebrush	0.00	0.00	0.00	100.00	0.00	1.03	23	0.20
gold medallion tree	0.00	0.00	0.00	100.00	0.00	1.03	22	0.19
peppermint tree	0.00	0.00	0.00	100.00	0.00	1.03	22	0.19
eastern redbud	0.00	0.00	0.00	100.00	0.00	1.03	20	0.17
paradise palm	0.00	0.00	0.00	100.00	0.00	1.03	20	0.17
kaffirboom coral tree	0.00	0.00	0.00	100.00	0.00	1.03	19	0.16
Carolina laurelcherry	0.00	0.00	0.00	100.00	0.00	1.03	18	0.16
euclayptus, beakpod	0.00	5.88	5.88	88.24	0.00	0.98	17	0.15
loquat	0.00	0.00	0.00	100.00	0.00	1.03	17	0.15
Victorian box	0.00	29.41	11.76	58.82	0.00	0.82	17	0.15
bottle tree	0.00	0.00	6.25	93.75	0.00	1.01	16	0.14
incense cedar	0.00	0.00	0.00	100.00	0.00	1.03	16	0.14
silk oak	0.00	0.00	12.50	87.50	0.00	0.99	16	0.14
weeping willow	0.00	0.00	0.00	100.00	0.00	1.03	16	0.14
bronze loquat	0.00	0.00	0.00	100.00	0.00	1.03	15	0.13
ginkgo	0.00	0.00	0.00	100.00	0.00	1.03	15	0.13
Florida hopbush	0.00	0.00	0.00	100.00	0.00	1.03	14	0.12
green acacia	0.00	14.29	42.86	42.86	0.00	0.82	14	0.12
Green Gem Indian laurel fig	0.00	0.00	0.00	100.00	0.00	1.03	14	0.12
mayten	0.00	0.00	0.00	100.00	0.00	1.03	14	0.12
primrose tree	0.00	0.00	7.14	92.86	0.00	1.01	14	0.12
tipu	0.00	14.29	0.00	85.71	0.00	0.95	14	0.12
avocado	0.00	7.69	23.08	69.23	0.00	0.92	13	0.11
Chinese privet	0.00	0.00	15.38	84.62	0.00	0.99	13	0.11
rubber tree	0.00	0.00	0.00	100.00	0.00	1.03	13	0.11
African sumac	0.00	0.00	0.00	100.00	0.00	1.03	12	0.10

Species	Dead or Dying	Poor	Fair	Good	N/A	RPI	# of Trees	% of Pop.
coast redwood	0.00	8.33	0.00	91.67	0.00	0.98	12	0.10
white alder	0.00	8.33	0.00	91.67	0.00	0.98	12	0.10
coastal live oak	0.00	0.00	9.09	90.91	0.00	1.00	11	0.10
date palm	0.00	0.00	0.00	100.00	0.00	1.03	11	0.10
naked coral tree	0.00	0.00	0.00	100.00	0.00	1.03	11	0.10
pink trumpet tree	0.00	0.00	18.18	81.82	0.00	0.98	11	0.10
willow	0.00	27.27	27.27	45.45	0.00	0.78	11	0.10
Chinese pistache	0.00	10.00	10.00	80.00	0.00	0.94	10	0.09
dragon tree	0.00	0.00	0.00	100.00	0.00	1.03	10	0.09
Japanese maple	0.00	10.00	20.00	70.00	0.00	0.91	10	0.09
Afghan pine	0.00	0.00	44.44	55.56	0.00	0.90	9	0.08
apple	0.00	0.00	0.00	100.00	0.00	1.03	8	0.07
Cape chesnut	0.00	12.50	37.50	50.00	0.00	0.84	8	0.07
common fig	0.00	12.50	0.00	87.50	0.00	0.96	8	0.07
Hong Kong orchid tree	0.00	12.50	25.00	50.00	12.50	0.75	8	0.07
Morton Bay fig	0.00	0.00	0.00	100.00	0.00	1.03	8	0.07
peach	0.00	0.00	0.00	100.00	0.00	1.03	8	0.07
pink melaleuca	0.00	0.00	62.50	37.50	0.00	0.84	8	0.07
poneytail palm	0.00	0.00	0.00	100.00	0.00	1.03	8	0.07
Carolina poplar	0.00	0.00	14.29	85.71	0.00	0.99	7	0.06
Wilson holly	0.00	0.00	0.00	100.00	0.00	1.03	7	0.06
apricot	0.00	16.67	0.00	83.33	0.00	0.93	6	0.05
Australian tea tree	0.00	0.00	0.00	100.00	0.00	1.03	6	0.05
deodar cedar	0.00	16.67	0.00	83.33	0.00	0.93	6	0.05
Guadalupe palm	0.00	0.00	0.00	100.00	0.00	1.03	6	0.05
shiny xylosma	0.00	0.00	0.00	100.00	0.00	1.03	6	0.05
sweetshade	0.00	0.00	0.00	100.00	0.00	1.03	5	0.04
Cape cheesewood	0.00	0.00	25.00	75.00	0.00	0.96	4	0.03
mimosa	0.00	0.00	25.00	75.00	0.00	0.96	4	0.03
river she-oak	0.00	0.00	0.00	100.00	0.00	1.03	4	0.03
silver maple	0.00	0.00	25.00	75.00	0.00	0.96	4	0.03
triangle palm	0.00	0.00	0.00	100.00	0.00	1.03	4	0.03
yucca	0.00	0.00	0.00	100.00	0.00	1.03	4	0.03
California palm	0.00	0.00	0.00	100.00	0.00	1.03	3	0.03
Chinese fringe tree	0.00	0.00	0.00	100.00	0.00	1.03	3	0.03
goldenrain tree	0.00	0.00	33.33	66.67	0.00	0.93	3	0.03
majestic palm	0.00	0.00	0.00	100.00	0.00	1.03	3	0.03
maple	0.00	0.00	0.00	100.00	0.00	1.03	3	0.03
mountain ebony	0.00	33.33	0.00	66.67	0.00	0.83	3	0.03
northern red oak	0.00	0.00	0.00	100.00	0.00	1.03	3	0.03
palm	0.00	0.00	0.00	100.00	0.00	1.03	3	0.03
pine	0.00	0.00	0.00	100.00	0.00	1.03	3	0.03

Species	Dead or Dying	Poor	Fair	Good	N/A	RPI	# of Trees	% of Pop.
pomegranate	0.00	0.00	0.00	100.00	0.00	1.03	3	0.03
ribbon gum eucalyptus	0.00	0.00	0.00	100.00	0.00	1.03	3	0.03
Catalina cherry	0.00	0.00	0.00	100.00	0.00	1.03	2	0.02
Chilean wine palm	0.00	0.00	0.00	100.00	0.00	1.03	2	0.02
Chinese hibiscus	0.00	0.00	0.00	100.00	0.00	1.03	2	0.02
Chinese holly	0.00	0.00	0.00	100.00	0.00	1.03	2	0.02
Indian hawthorne	0.00	0.00	0.00	100.00	0.00	1.03	2	0.02
mesquite	0.00	0.00	0.00	100.00	0.00	1.03	2	0.02
Oriental arborvitae	0.00	0.00	0.00	100.00	0.00	1.03	2	0.02
pecan	0.00	0.00	0.00	100.00	0.00	1.03	2	0.02
pineapple guava	0.00	0.00	0.00	100.00	0.00	1.03	2	0.02
saucer magnolia	0.00	0.00	0.00	100.00	0.00	1.03	2	0.02
silverleaf stringybark	0.00	0.00	50.00	50.00	0.00	0.88	2	0.02
yellow oleander	0.00	0.00	0.00	100.00	0.00	1.03	2	0.02
American elm	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
coast beefwood	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
cockspur coral tree	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
common plum	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
Desert Museum palo verde	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
dombeya	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
dwarf blue gum	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
fig	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
flowering cherry	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
grapefruit	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
hackberry	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
jelecote pine	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
Jerusalem thorn	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
juniper	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
kaffir plum	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
long-leafed yellowwood	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
macadamia	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
Mexican blue fig	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
Mexican shrubby spurge	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
Minneola tangelo	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
palo verde	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
rusty leaf fig	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
silk floss tree	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
sugar bush	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
sugargum	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
tangerine	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01

Species	Dead or Dying	Poor	Fair	Good	N/A	RPI	# of Trees	% of Pop.
tulip tree	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
tupidanthus	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
velvet ash	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
western redbud	0.00	0.00	0.00	100.00	0.00	1.03	1	0.01
Citywide	**0.05**	**1.99**	**6.33**	**91.57**	**0.06**	**1.00**	**11,575**	**100%**