URBAN FOREST RESOURCE ANALYSIS OF INVENTORIED PUBLIC TREES

City of North Las Vegas, Nevada

June 2013

DAVEY RESOURCE GROUP
A Division of The Davey Tree Expert Company

City of North Las Vegas, Nevada

Resource Analysis

of Inventoried Public trees

June 2013

Prepared for

Nevada Division of Forestry

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Acknowledgements

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

Table of Contents

Executive Summary 1

Introduction 2

Chapter 1: Urban Forest Resource Summary 4

- Summary of Urban Forest Resource Structure 4
- Summary of Urban Forest Benefits 4
- Urban Forest Resource Management 5

Chapter 2: North Las Vegas' Urban Forest Resource 6

- Population Composition 6
- Species Richness and Composition 7
- Species Importance 10
- Canopy Cover 11
- Relative Age Distribution 11
- Urban Forest Condition and Relative Performance 15
- Replacement Value 18

Chapter 3: Urban Forest Resource Benefits 21

- Energy Savings 21
- Electricity and Natural Gas Reduction 22
- Atmospheric Carbon Dioxide Reduction 24
  - Sequestered Carbon Dioxide 25
- Air Quality Improvement 27
  - Deposition and Interception 28
  - Avoided Pollutants 28
  - BVOC Emissions 28
  - Net Air Quality Improvement 28
- Stormwater Runoff Reductions 31
- Aesthetic, Property Value and Socioeconomic Benefits 33
- Net Benefits and Benefit-Investment Ratio (BIR) 37

Conclusion 40

Appendix A: Methods and Procedures 41

Appendix B: References 43

Appendix C: Reports 45

Figures

Figure 1. Overall Composition of North Las Vegas' Inventoried Public Tree Population 6
Figure 2. Frequency of Top 10 Species in North Las Vegas' Inventoried Public Tree Population 7
Figure 3. Overall Relative Age Distribution of North Las Vegas' Tree Inventory 12
Figure 4. Relative Age Distribution of North Las Vegas' Top Nine Inventoried Tree Species 14
Figure 5. Condition of North Las Vegas' Inventoried Public Trees 15
Figure 6. Annual Electricity and Natural Gas Benefits - Top Five Species 22
Figure 7. Annual Reduction of CO_2 - Top Five species 25
Figure 8. Annual Improvement to Air Quality - Top Five Species 29
Figure 9. Annual Reduction in Stormwater Runoff - Top Five Species 31
Figure 10. Annual Increase in Property and Socioeconomic Values - Top Five Species 33
Figure 11. Summary of Annual per Tree Benefits 35
Figure 12. Total Annual Benefits from North Las Vegas' Inventoried Trees 38
Figure 13. Total Annual Investment to Maintain North Las Vegas' Inventoried Trees 38
Figure 14. Benefit versus Investment Ratio 39

Tables

Table 1. Population Distribution of North Las Vegas' Public Tree Inventory 8
Table 2. Importance Value (IV) of North Las Vegas' Most Abundant PublicTree Species 11
Table 3. Relative Performance Index (RPI) for North Las Vegas' 16
Table 4. Tree Species Which May Be Underused, ... 17
Table 5. Replacement Value of North Las Vegas' Public Trees 19
Table 6. Annual Electric and Natural Gas Benefits from North Las Vegas' Inventoried Public Trees 23
Table 7. Annual CO_2 Reduction Benefits Provided by North Las Vegas' Inventoried Public Trees 26
Table 8. Number of Days Exceeding Federal Ground-Level Ozone 27
Table 9. Annual Air Quality Improvements Provided by North Las Vegas' Inventoried Public Trees 30
Table 10. Annual Stormwater Runoff Reduction Benefits Provided by North Las Vegas' Inventoried Public Trees 32
Table 11. Annual Property Value, Aesthetic, and Socioeconomic Benefits 34
Table 12. Summary of Current Annual Average per Tree Benefits ($/Tree/yr.) from North Las Vegas' Inventoried Tree Resource 36
Table 13. Annual Benefit Versus Investment Summary for North Las Vegas' Inventoried Tree Resource 39
Table 14. North Las Vegas Benefit Prices Used In This Analysis 42

Executive Summary

Trees play a vital role in the community of North Las Vegas, Nevada. They provide numerous benefits both tangible and intangible, to residents, visitors, and neighboring communities. Dedicated to maintaining 10,910 trees, North Las Vegas has demonstrated that public trees are a valued community resource, an important component of the urban infrastructure, and a part of the city's identity.

The Nevada Division of Forestry (NDF) has an interest in supporting urban forest management across the state. In 2012, NDF contracted with Davey Resource Group (DRG) to collect an inventory of public trees within an area designated as the Clark County Area of Interest (AOI). The AOI encompassed multiple entities, including the City of North Las Vegas, Las Vegas, Mesquite, Boulder City, unincorporated Clark County, and the University of Nevada Las Vegas (UNLV). During the inventory, a certified arborist briefly inspected each tree and recorded information including species, size, condition, geographic location, and current maintenance needs. Arborists collected this information for nearly 100,000 individual tree sites across the AOI. For the City of North Las Vegas, this included 10,910 individual trees and vacant planting sites. Upon completion of the inventory for each entity, DRG performed a detailed and quantified analysis of the current structure, function, and value of this tree resource using the inventory data in conjunction with i-Tree benefit-cost modeling software.

North Las Vegas' public trees in the inventoried areas are providing annual benefits of $364,656 ($1.63 per capita). These benefits include energy savings, air quality improvements, stormwater interception, atmospheric CO_2 reduction, and aesthetic contributions to the social and economic health of the community.

North Las Vegas' public tree resource is reducing annual electric energy consumption by 508 megawatts (MWh) and annual natural gas consumption by 3,607 therms, for a combined value of $36,425 annually. In addition, these trees are removing 1,347 pounds 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 air quality benefit of $17,372. Canopy from this population covers 60 acres. This canopy reduces annual stormwater runoff by 3.5 million gallons and protects local water resources by reducing sediment and pollution loading.

North Las Vegas' tree population is young and comprised of many small-stature trees. Therefore, the benefits provided to the City do not currently outweigh the cost of maintenance and planting. However, as existing populations of medium and large-stature trees grow in the landscape, the benefits can be expected to increase. The total investment in maintenance for the inventoried trees is $565,000. For every $1 invested in this resource, North Las Vegas is receiving $0.65 in benefits.

Trees are a part of the community infrastructure. However, unlike other public assets, with proper maintenance, trees have the potential to increase in value over time. North Las Vegas' inventoried tree resource is a relatively young population in overall fair condition. With more than 88 different species, North Las Vegas is well positioned to realize a significant increase in environmental benefits as tree populations continue to mature. An ongoing commitment to maximizing and maintaining the health of the urban forest will ensure that the community continues to be a healthy, safe, and enjoyable place to live.

Introduction

Incorporated in 1946, the City of North Las Vegas is located just northeast of Las Vegas and is the fourth largest city in the state of Nevada. Encompassing an area of 100.43 square miles at an elevation of around 2,205 feet above sea level, North Las Vegas is one of the driest places in the country. Despite the challenges imposed by climate, the City has invested in planting and maintaining over 10,900 trees in public areas. These trees compose North Las Vegas' urban forest. The population, currently 224,003, has grown 460% since 1990. In recent years, however, growth has tapered off.

Individual trees and a healthy urban forest play important roles 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 North Las Vegas a more enjoyable place to live, work, and play. The City's 10,910 public trees play a prominent role in the overall urban forest benefits afforded to the community. Residents rely on the City of North Las Vegas to protect and maintain this vital resource.

The City of North Las Vegas participated in a Nevada Division of Forestry (NDF) sponsored project in 2012 to inventory a portion of their public trees. By participating, North Las Vegas reflects the community's appreciation, concern, and proactive stance on the management of public trees.

A team of International Society of Arboriculture certified arborists from Davey Resource Group (DRG) mapped the location and collected data on publicly owned trees using global positioning system technology. In addition to location, the arborists collected information about the species, size, condition, and current maintenance needs of each tree. An urban forest is a dynamic resource, constantly changing and growing in response to environment and care. It is critical for the City to update the inventory data, using asset management software, as maintenance needs are addressed and trees mature.

The inventory data was analyzed with i-Tree's *Streets*, a STRATUM Analysis Tool (*Streets* v5.0.1; i-Tree v5.0.6), to develop a resource analysis and report of the current condition of the inventoried urban forest. This report, unique to North Las Vegas, effectively quantifies the value of the community's public 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 a subset of the public urban forest, including 10,910 trees and 153 vacant sites. 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 North Las Vegas' inventoried 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.

It is important to note that the inventory for North Las Vegas is incomplete. As the goal of the overall project was to gain an understanding of trends of the urban forest across the entire area of interest, funding for a complete inventory of trees in each entity was not available. This report should be used to help gain an understanding of the importance of the urban forest and the values it provides. It is estimated that the benefits shown in this report account for only selected neighborhoods in North Las Vegas.

Chapter 1: Urban Forest Resource Summary

Summary of Urban Forest Resource Structure

North Las Vegas' inventoried urban forest resource includes 10,910 publicly managed trees and 153 available planting sites.

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:

- There were 88 unique tree species identified in the inventory. The predominant tree species are *Pinus eldarica* (Mondale pine, 12.2%), *Fraxinus velutina* 'Fan-Tex' (Fan-Tex ash, 11.4%) and *Pinus halepensis* (Aleppo pine, 8.3%).
- The age structure of the inventoried tree population is young overall, with 64.6% of trees measuring between 0 to 6 inches DBH (diameter at breast height, measured at 4'6" above the ground) and 86.4% measuring under 12 inches DBH.
- More than half of the inventoried trees (52.3%) are in fair condition and 38% are in good condition.
- To date, the inventoried tree population has sequestered 1,694 tons of carbon (CO_2), valued at approximately $25,409.
- Replacement of North Las Vegas' 10,910 inventoried trees with trees of similar size, species, and condition would cost more than $28.1 million.

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Summary of Urban Forest Benefits

Annually, North Las Vegas' inventoried public trees provide cumulative benefits to the community at an average value of $33.42 per tree, for a total gross value of $364,656 per year. These annual benefits include:

- Trees reduce electricity and natural gas use in their neighborhoods through shading and climate effects for an overall benefit of $36,425, an average of $3.34 per tree.
- Trees sequester 189 tons of atmospheric CO_2 per year. An additional 254 tons are avoided[1] by reducing energy generation, resulting in a net value of $6,403 and an average of $0.59 per tree.
- Net air quality improvements, including removal and avoidance of pollutants, provided by the city tree population are valued at $17,372, an average per tree benefit of $1.59 annually.
- North Las Vegas' inventoried trees intercept an estimated 3.5 million gallons of stormwater annually for a total value of $16,710, an average of $1.53 per tree.

[1] Avoided pollution is a result of reducing energy consumption. The avoided value represents pollution that would have resulted from the generation of additional energy.

- The benefit contributed by North Las Vegas' inventoried public trees to property value increases, aesthetics, and socioeconomics equals $287,746, an average of $26.37 per tree.
- When the City's estimated annual investment of $565,000 for maintenance of this resource is considered, the annual net benefit (benefits minus investment) to the City is -$200,344, an average of -$18.36 per tree. In other words, **for every $1 invested in public trees, North Las Vegas receives $0.65 in benefits.**

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Urban Forest Resource Management

North Las Vegas' public tree population is a dynamic resource that requires continued investment to maintain and realize its full benefit potential. **These community trees are one of the few 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. .

North Las Vegas has the benefit of a relatively young urban forest in good condition. The City should focus resources on maximizing the flow of benefits from the current tree population and maintaining a forward-thinking approach. Based on the resource analysis, DRG recommends the following:

- Maintain an appropriate age distribution by continuing to plant new trees to improve long-term resource sustainability and greater canopy coverage. To maximize benefits, focus on medium to large-stature trees where planting sites allow.
- Maximize the condition of the existing tree resource through continuing comprehensive tree maintenance and a cyclical pruning schedule.
- Continue annual tree planting efforts with the goal of achieving a 100% stocking rate, utilizing available planting sites identified by the inventory.
- Implement a structural pruning program for young and establishing trees to promote healthy structure, extend life expectancy, and reduce future costs and liability.
- Maintain and update the inventory database.

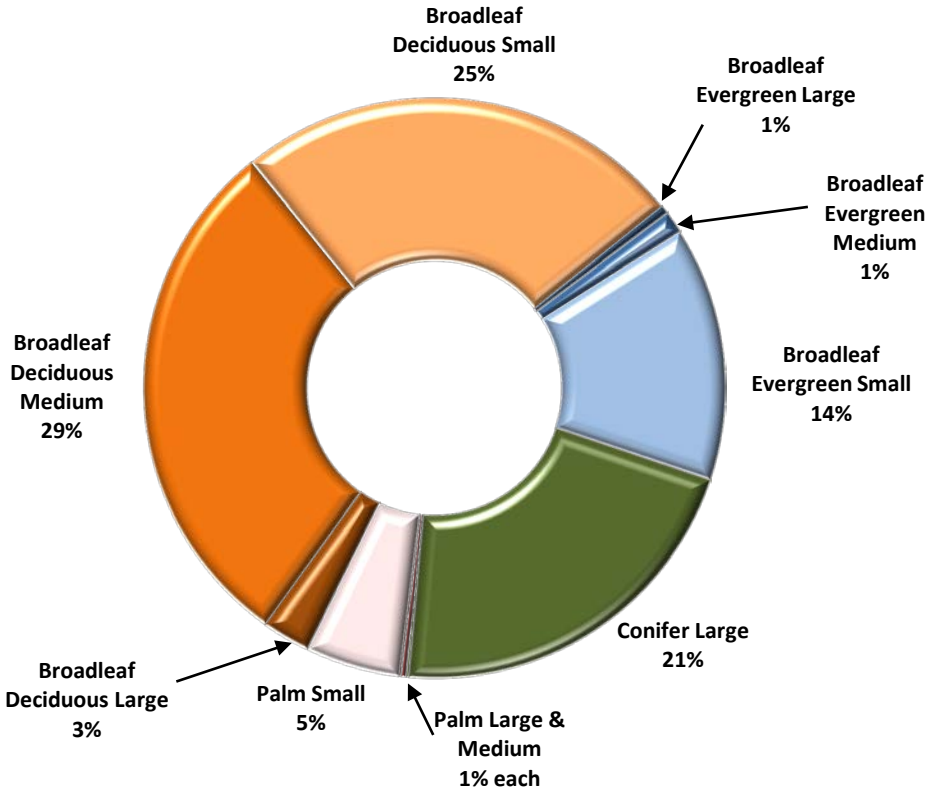
The value of North Las Vegas' inventoried tree resource should continue to increase as existing trees mature and new trees are planted. As the resource grows, investment in management is critical to ensuring that residents will continue receiving a high return on investment in the future. It is not as simple as planting more trees to increase canopy cover and benefits. Planning and funding for tree care and tree management must complement planting efforts in order to ensure the long-term success and health of North Las Vegas' urban forest. 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 street trees improve the quality of life in the City.

Chapter 2: North Las Vegas' Urban Forest Resource

A city's urban forest resource is more thoroughly understood through examination of composition species richness (diversity). Inferences based on this data can help managers understand the importance of individual tree species to the overall forest as it exists today. Consideration of stocking level (trees per available space), canopy cover, age distribution, condition, and performance helps to project the potential of the forest resource.

Population Composition

Broadleaf species are the most common among North Las Vegas' inventoried public tree population, comprising 73% of the total inventory. Broadleaf trees typically have larger canopies than coniferous trees of the same size diameter. Since many of the measurable benefits derived from trees are directly related to leaf surface area, broadleaf trees generally provide the highest level of benefits to a community. Larger-statured broadleaf tree species provide greater benefits than smaller-statured trees, independent of diameter. Deciduous broadleaf species make up 57% of North Las Vegas' public tree population, including 3% large-stature, 29% medium-stature, and 25% small-stature trees. Evergreen broadleaf trees comprise 16% of the population, including 1% medium- and large-stature, and 14% small-stature. Conifers represent 21% of the overall population, and they are primarily large-stature trees. Approximately 6% of the population is comprised of palms (Figure 1 and Table 1).



Conifer Small, Conifer Medium and Palm Large represent <1% each

Figure 1. Overall Composition of North Las Vegas' Inventoried Public Tree Population

Species Richness and Composition

North Las Vegas' inventoried public tree population (Table 1 and Appendix C) includes a mix of 88 unique species, slightly more than that of the mean of 53 species reported by McPherson and Rowntree (1989) in their nationwide survey of street tree populations in 22 U.S. cities. The top 10 species represent 60% of the total population (Figure 2). The predominant tree species are *Pinus eldarica* (Mondale pine, 12.2%), *Fraxinus velutina* 'Fan-Tex' (Fan-Tex ash, 11.4%) and *Pinus halepensis* (Aleppo pine, 8.3%).

There is a widely accepted rule that no single species should represent greater than 10% of the total population, while no single genus more than 20% (Clark Et al, 1997). The genus *Pinus* (20.4%) is over-represented as more than 20% of the population, and both *Pinus eldarica* and *Fraxinus velutina* 'Fan-Tex' exceed the 10% species rule. New plantings in the immediate future should limit these species to reduce overreliance.

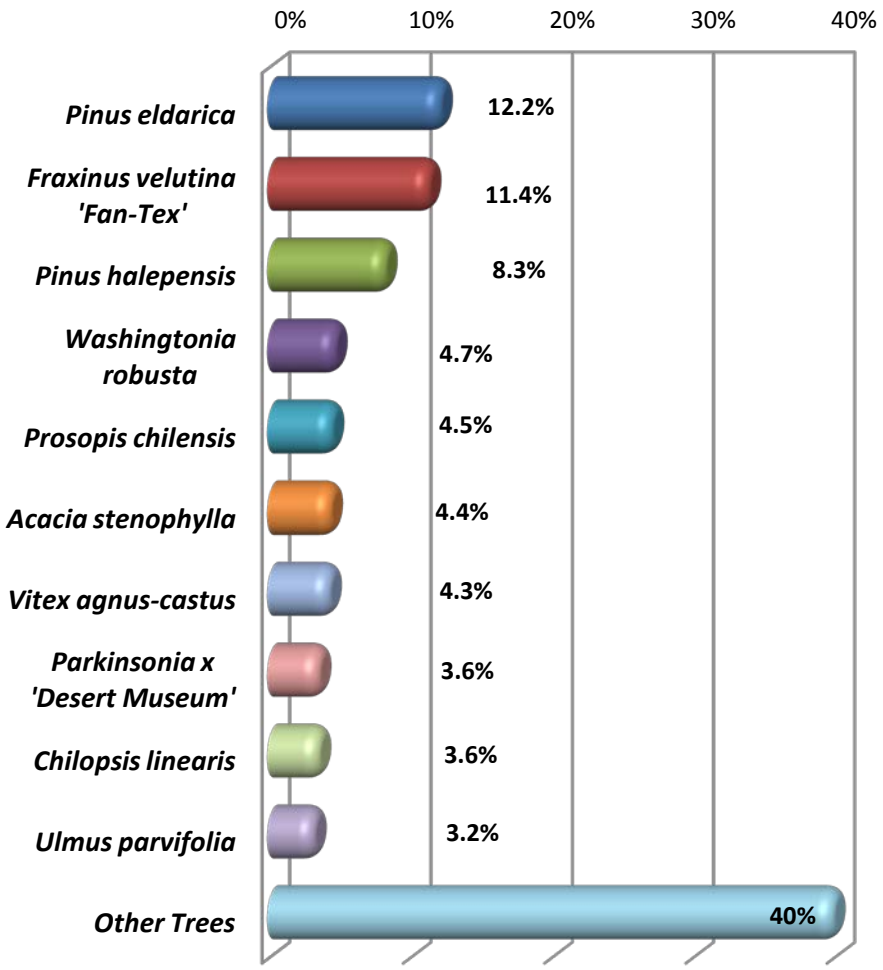


Figure 2. Frequency of Top 10 Species in North Las Vegas' Inventoried Public Tree Population

It is important to maintain a diverse population within an urban forest. 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 investments 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.

Table 1. Population Distribution of North Las Vegas' Public Tree Inventory

	DBH Class (in)									
Species	**0-3**	**3-6**	**6-12**	**12-18**	**18-24**	**24-30**	**30-36**	**>36**	**Total**	**% of Pop.**
Broadleaf Deciduous Large (BDL)										
Gleditsia triacanthos	64	35	40	13	3	0	0	0	155	1.4
BDL OTHER	17	14	48	17	25	12	5	0	138	1.3
Total	**81**	**49**	**88**	**30**	**28**	**12**	**5**	**0**	**293**	**2.7**
Broadleaf Deciduous Medium (BDM)										
Fraxinus velutina 'Fan-Tex'	429	515	261	27	4	3	0	0	1,239	11.4
Prosopis chilensis	234	199	50	6	0	0	0	0	489	4.5
Ulmus parvifolia	78	242	32	0	0	0	0	0	352	3.2
Pistacia chinensis	126	101	75	2	0	0	0	0	304	2.8
Parkinsonia florida	9	77	62	5	0	0	0	0	153	1.4
Morus alba	10	5	29	41	41	19	2	0	147	1.3
Fraxinus angustifolia	47	52	32	4	0	0	0	0	135	1.2
BDM OTHER	125	125	71	38	11	1	1	0	372	3.4
Total	**1,058**	**1,316**	**612**	**123**	**56**	**23**	**3**	**0**	**3,191**	**29.2**
Broadleaf Deciduous Small (BDS)										
Vitex agnus-castus	388	59	17	5	0	1	0	0	470	4.3
Parkinsonia x 'Desert Museum'	229	140	20	0	0	0	0	0	389	3.6
Chilopsis linearis	243	132	13	0	0	0	0	0	388	3.6
Acacia farnesiana	96	182	19	1	0	0	0	0	298	2.7
Chitalpa tashkentensis	131	130	18	1	0	0	0	0	280	2.6
Prosopis torreyana	54	129	60	3	0	0	0	0	246	2.3
Cercidium praecox	140	56	6	0	0	0	0	0	202	1.9
Prosopis velutina	21	61	77	15	1	0	0	0	175	1.6
Prosopis glandulosa	75	63	6	2	0	0	0	0	146	1.3
BDS OTHER	107	30	4	1	0	0	0	0	142	1.3
Total	**1,484**	**982**	**240**	**28**	**1**	**1**	**0**	**0**	**2,736**	**25.1**
Broadleaf Evergreen Large (BEL)										
BEL OTHER	24	22	3	3	1	0	0	0	53	0.5
Total	**24**	**22**	**3**	**3**	**1**	**0**	**0**	**0**	**53**	**0.5**
Broadleaf Evergreen Medium (BEM)										
Quercus virginiana	18	75	30	1	0	0	0	0	124	1.1

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	>36	Total	% of Pop.
BEM OTHER	0	1	8	3	1	0	0	0	13	0.1
Total	**18**	**76**	**38**	**4**	**1**	**0**	**0**	**0**	**137**	**1.3**
Broadleaf Evergreen Small (BES)										
Acacia stenophylla	249	182	47	1	0	0	0	0	479	4.4
Rhus lancea	114	150	70	3	0	0	0	0	337	3.1
Olea europaea	85	101	58	4	1	0	0	0	249	2.3
Sophora secundiflora	157	7	1	0	0	0	0	0	165	1.5
BES OTHER	149	97	62	9	2	0	0	0	319	2.9
Total	**754**	**537**	**238**	**17**	**3**	**0**	**0**	**0**	**1,549**	**14.2**
Conifer Evergreen Large (CEL)										
Pinus eldarica	185	344	595	177	23	4	0	0	1,328	12.2
Pinus halepensis	3	36	269	437	138	16	2	0	901	8.3
CEL OTHER	14	16	31	22	6	1	0	0	90	0.8
Total	**202**	**396**	**895**	**636**	**167**	**21**	**2**	**0**	**2,319**	**21.3**
Conifer Evergreen Medium (CEM)										
CEM OTHER	2	0	2	10	2	0	0	0	16	0.1
Total	**2**	**0**	**2**	**10**	**2**	**0**	**0**	**0**	**16**	**0.1**
Palm Evergreen Large (PEL)										
PEL OTHER	0	0	0	29	0	0	1	0	30	0.3
Total	**0**	**0**	**0**	**29**	**0**	**0**	**1**	**0**	**30**	**0.3**
Palm Evergreen Medium (PEM)										
PEM OTHER	0	0	1	15	0	0	0	0	16	0.1
Total	**0**	**0**	**1**	**15**	**0**	**0**	**0**	**0**	**16**	**0.1**
Palm Evergreen Small (PES)										
Washingtonia robusta	28	14	264	203	6	0	0	0	515	4.7
PES OTHER	0	0	4	22	13	14	2	0	55	0.5
Total	**28**	**14**	**268**	**225**	**19**	**14**	**2**	**0**	**570**	**0.1**
Citywide Total	**3,651**	**3,392**	**2,385**	**1,120**	**278**	**71**	**13**	**0**	**10,910**	**100%**

Species Importance

To quantify the significance of any one particular species to North Las Vegas' urban forest, an *importance value* (IV) is derived for each of the most common species. Importance values are particularly meaningful to urban forest managers because they indicate a community's reliance on the functional capacity of 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 in the City's urban forest population. Since 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 costs.

The 25 most abundant species each represent greater than 1% of the total population. Together, these 25 species represent 89% of the total population, 84% of the total leaf area, and 86% of the total canopy cover for a combined importance value of 86 (Table 2). Of these species, North Las Vegas relies most on *Pinus halepensis* (Aleppo pine, IV=19.6), followed by *Pinus eldarica* (Mondale pine, IV=12.3) and *Fraxinus velutina* 'Fan-Tex' (Fan-Tex ash, IV=10.9).

Due to their large or medium stature and high leaf surface area, some species provide more impact than their population numbers alone would suggest. For example, North Las Vegas' *Morus alba* (white mulberry, IV=4.1) represents just 1.4% of the tree population but is providing 5.5% of the canopy cover. *Ulmus parvifolia* (Chinese elm, IV=3.4) represents just 3.2% of the population while providing 4.2% of the canopy. Both of these species are large-stature deciduous hardwoods that grow vigorously and often have higher maintenance needs. Their maintenance needs may be justified, however, considering the benefits provided by these trees are relatively high.

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, *Acacia stenophylla* (shoestring acacia) and *Chilopsis linearis* (desert willow) represent 4.4% and 3.6% of the population, but because of their small-stature, their importance values are just 2.72 and 1.73 respectively (Table 2).

Table 2. Importance Value (IV) of North Las Vegas' Most Abundant Public Tree Species

Species	Number of Trees	% of Pop.	Leaf Area (ft^2)	% of Total Leaf Area	Canopy Cover (ft^2)	% of Total Canopy Cover	Importance Value
Pinus eldarica	1,328	12.17	944,303	12.53	317,115	12.18	**12.30**
Fraxinus velutina 'Fan-Tex'	1,239	11.36	692,312	9.19	317,513	12.20	**10.91**
Pinus halepensis	901	8.26	2,268,955	30.12	527,747	20.27	**19.55**
Washingtonia robusta	515	4.72	125,932	1.67	35,036	1.35	**2.58**
Prosopis chilensis	489	4.48	183,279	2.43	84,977	3.26	**3.39**
Acacia stenophylla	479	4.39	136,408	1.81	50,921	1.96	**2.72**
Vitex agnus-castus	470	4.31	63,665	0.85	40,077	1.54	**2.23**
Parkinsonia x 'Desert Museum'	389	3.57	66,954	0.89	41,608	1.60	**2.02**
Chilopsis linearis	388	3.56	51,385	0.68	24,598	0.94	**1.73**
Ulmus parvifolia	352	3.23	203,996	2.71	110,248	4.23	**3.39**
Rhus lancea	337	3.09	131,820	1.75	51,285	1.97	**2.27**
Pistacia chinensis	304	2.79	125,328	1.66	55,921	2.15	**2.20**
Acacia farnesiana	298	2.73	69,432	0.92	41,241	1.58	**1.75**
Chitalpa tashkentensis	280	2.57	57,476	0.76	34,602	1.33	**1.55**
Olea europaea	249	2.28	68,741	0.91	27,121	1.04	**1.41**
Prosopis torreyana	246	2.25	83,458	1.11	46,438	1.78	**1.72**
Cercidium praecox	202	1.85	38,162	0.51	21,532	0.83	**1.06**
Prosopis velutina	175	1.60	167,727	2.23	76,904	2.95	**2.26**
Sophora secundiflora	165	1.51	21,122	0.28	6,980	0.27	**0.69**
Gleditsia triacanthos	155	1.42	137,407	1.82	37,246	1.43	**1.56**
Parkinsonia florida	153	1.40	107,351	1.42	68,740	2.64	**1.82**
Morus alba	147	1.35	414,040	5.50	141,927	5.45	**4.10**
Prosopis glandulosa	146	1.34	46,564	0.62	21,280	0.82	**0.92**
Fraxinus angustifolia	135	1.24	76,168	1.01	35,592	1.37	**1.21**
Quercus virginiana	124	1.14	58,219	0.77	26,087	1.00	**0.97**
Other Trees	1,244	11.40	1,193,482	15.84	360,786	13.86	**13.70**
Citywide Total	**10,910**	**100%**	**7,533,685**	**100%**	**2,603,522**	**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. Overall, the inventoried trees provide 59.8 acres of tree canopy cover. *Pinus halepensis* (Aleppo pine) and *Fraxinus velutina* 'Fan–Tex' (Fan-Tex ash) provide the largest proportion of canopy, accounting for 20.3% and 12.2% of the total canopy, respectively.

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 DBH less than eight inches, while only 10% should be in the large diameter classes (>24 inches).

Overall, the age distribution of North Las Vegas' urban forest is weighted towards young trees (Figure 3), with 65% of the population consisting of trees with a DBH of six inches or smaller. Established trees (6-18 inches DBH) comprise 32%, and mature trees (>18 inches DBH) make up less than 3% of the overall population. With continued proactive management of this young urban forest, North Las Vegas can expect increasing benefits as this resource matures. North Las Vegas has very few trees in the large diameter classes (>24"). This may be, at least in part, a result of the arid environment rather than the overall age of the street tree population. Trees in the older age classes provide greater benefits due to their high leaf surface area. Emphasis should be placed on preserving older trees.

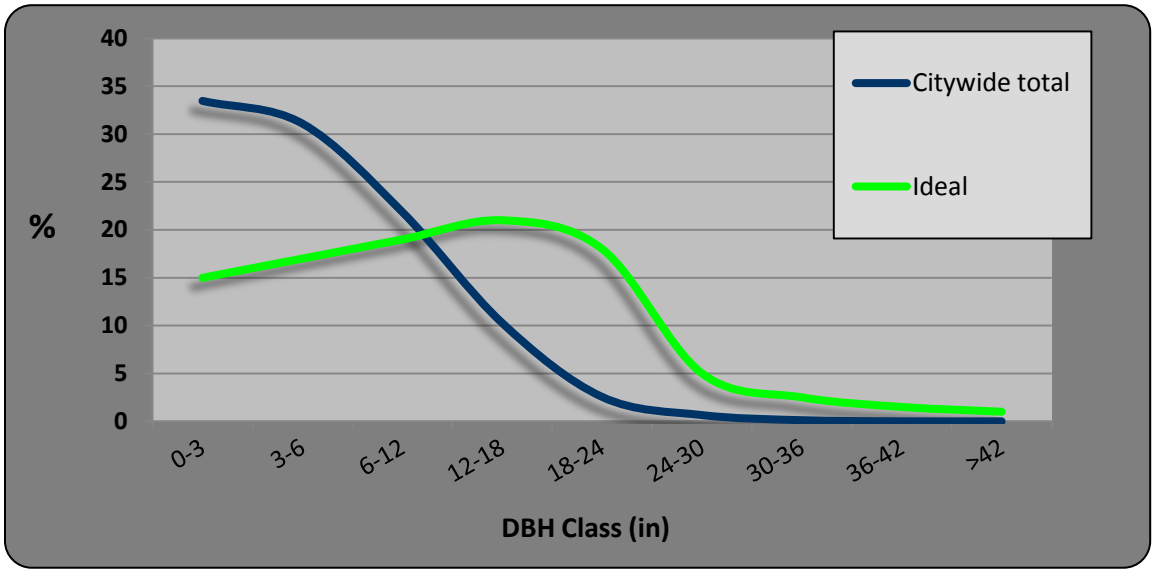


Figure 3. Overall Relative Age Distribution of North Las Vegas' Tree Inventory

Of North Las Vegas' nine most common species, the youngest population is likely *Chilopsis linearis* (desert willow, 96.7% under 6" DBH).

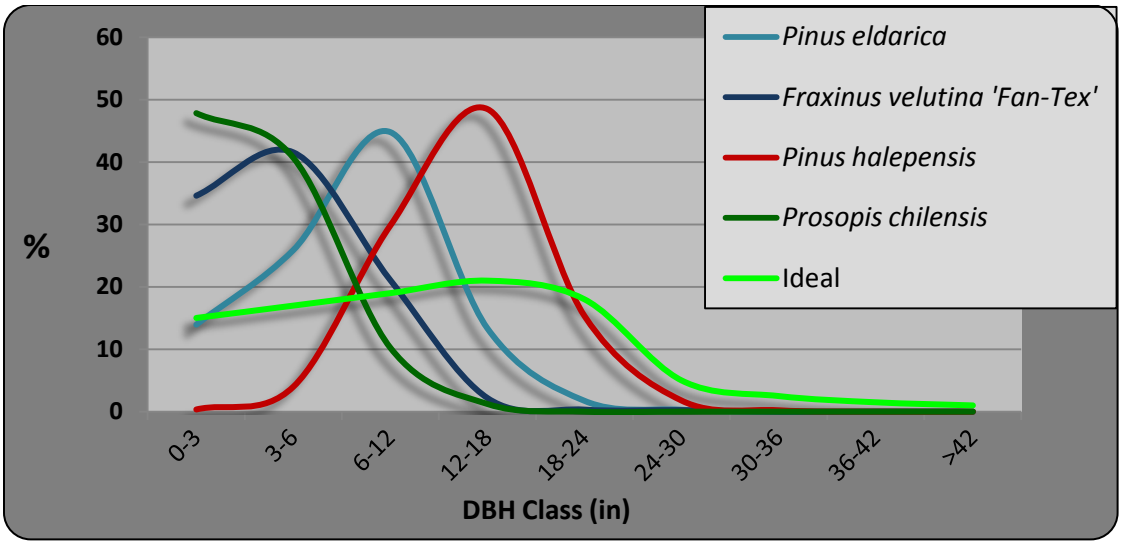
Prosopis chilensis (Chilean mesquite, 89% under 6" DBH) is a medium-stature tree well represented in the young age classes. This species has considerable potential to increase in value and benefit with appropriate maintenance. Four of the nine most common species are small-stature trees with significant representation in the small DBH classes. Because these species are smaller at maturity, this is not necessarily an indication of young age. *Vitex agnus-castus* (chaste tree, 95.1% under 6" DBH), *Chilopsis linearis* (desert willow, 96.7% under 6" DBH), and *Parkinsonia x 'Desert Museum'* (desert museum palo verde, 94.9% under 6" DBH) are small-stature populations that are likely to continue to provide benefits at a flat or declining rate over time.

Pinus eldarica (Mondale pine) and *Pinus halepensis* (Aleppo pine) are the only established populations of large-stature trees. These species will continue to provide increased benefits over time.

As young populations mature and eventually grow old, their maintenance needs are likely to increase. Future plantings should adequately represent long-standing and high-performing species. Sufficient replacements should be planted to ensure the functional capacity and benefit streams from these populations, even as individuals begin to decline.

With a relatively young urban forest and proactive management, North Las Vegas can expect greater benefits as large-stature trees mature. New installations should carefully consider species selection, increasing the use of underused and well-performing species, and focusing on medium and large-statured species.

In addition to planting, it is critical to dedicate resources to ensuring proper maintenance as trees mature. A long-term, sustainable management plan, including regular inspection and pruning cycles, can ensure North Las Vegas' urban forest remains healthy and well-structured, thereby maximizing environmental services to the community, reducing risk, and promoting a consistent flow of benefits for many generations to come.



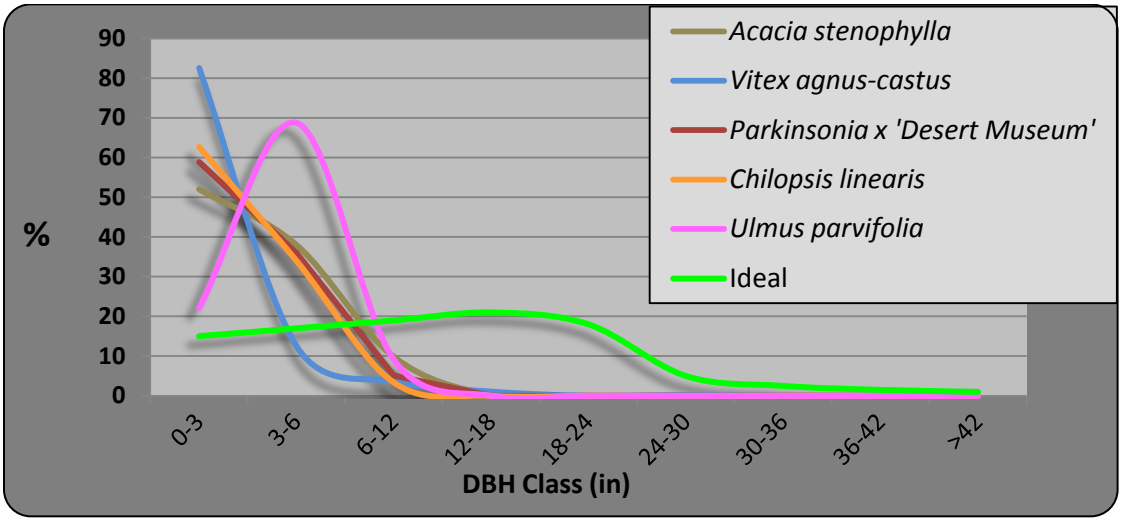


Figure 4. Relative Age Distribution of North Las Vegas' Top Nine Inventoried Tree Species

Urban Forest Condition and Relative Performance

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.). Each inventoried tree was rated for overall condition, including consideration for structure, foliage, and the root collar. When trees are performing at their peak, the benefits they provide are maximized. The inventory found 52% of North Las Vegas' trees in fair condition and X% in good condition. Nearly 10% of the population was determined to be in poor condition. Removal or mitigation of failing trees is recommended as soon as possible to reduce liability exposure.

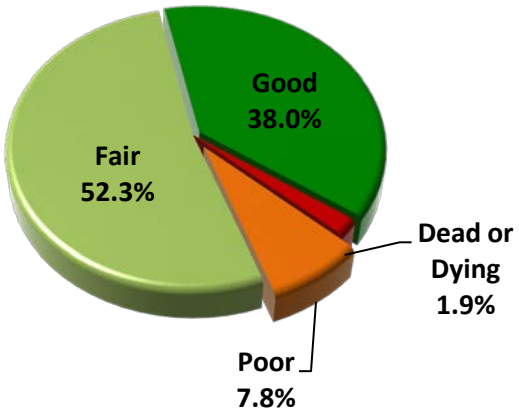


Figure 5. Condition of North Las Vegas' Inventoried Public Trees

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 25 most common species collected by the inventory, 14 have an RPI of 1.0 or greater (Table 3). Of these, *Washingtonia robusta* (Mexican fan palm) has the highest RPI of 1.17, while *Gleditsia triacanthos* (honey locust, RPI=0.86*)* has the lowest (Table 3).

Table 3. Relative Performance Index (RPI) for North Las Vegas' Inventoried Public Trees

Species	Dead or Dying	Poor	Fair	Good	N/A	RPI	# of Trees	% of Pop.
Pinus eldarica	0.83	2.94	43.15	53.09	0.00	**1.08**	1,328	12.17
Fraxinus velutina 'Fan-Tex'	4.52	11.14	58.51	25.42	0.40	**0.92**	1,239	11.36
Pinus halepensis	1.78	6.10	69.48	22.64	0.00	**0.95**	901	8.26
Washingtonia robusta	0.19	0.58	27.38	71.84	0.00	**1.17**	515	4.72
Prosopis chilensis	1.43	11.04	39.26	48.26	0.00	**1.03**	489	4.48
Acacia stenophylla	0.21	1.67	31.73	66.39	0.00	**1.14**	479	4.39
Vitex agnus-castus	1.06	5.32	39.79	53.83	0.00	**1.08**	470	4.31
Parkinsonia x 'Desert Museum'	0.26	7.20	61.95	30.59	0.00	**0.99**	389	3.57
Chilopsis linearis	1.80	11.08	53.61	33.51	0.00	**0.97**	388	3.56
Ulmus parvifolia	1.42	13.35	65.91	19.32	0.00	**0.91**	352	3.23
Rhus lancea	0.59	4.75	58.75	35.91	0.00	**1.01**	337	3.09
Pistacia chinensis	1.97	13.16	58.55	26.32	0.00	**0.94**	304	2.79
Acacia farnesiana	0.00	2.01	41.61	56.38	0.00	**1.11**	298	2.73
Chitalpa tashkentensis	2.50	13.57	70.00	13.93	0.00	**0.88**	280	2.57
Olea europaea	0.40	1.61	67.07	30.92	0.00	**1.01**	249	2.28
Prosopis torreyana	1.22	8.54	56.50	33.74	0.00	**0.99**	246	2.25
Cercidium praecox	0.99	5.94	51.49	41.58	0.00	**1.03**	202	1.85
Prosopis velutina	1.71	5.71	54.29	38.29	0.00	**1.01**	175	1.60
Sophora secundiflora	0.00	1.82	49.70	48.48	0.00	**1.08**	165	1.51
Gleditsia triacanthos	3.23	20.65	61.29	14.84	0.00	**0.86**	155	1.42
Parkinsonia florida	0.00	6.54	67.97	25.49	0.00	**0.97**	153	1.40
Morus alba	6.80	5.44	70.75	17.01	0.00	**0.89**	147	1.35
Prosopis glandulosa	1.37	6.16	43.15	49.32	0.00	**1.05**	146	1.34
Fraxinus angustifolia	3.70	9.63	42.22	44.44	0.00	**1.00**	135	1.24
Quercus virginiana	0.00	2.42	67.74	29.84	0.00	**1.00**	124	1.14
Other Trees	4.02	15.11	50.96	29.90	0.00	**0.00**	1,244	11.40
Citywide Total	**1.89**	**7.82**	**52.25**	**37.99**	**0.05**	**1.00**	**10,910**	**100%**

The RPI can be a useful tool for urban forestry managers. For example, if a community has been planting two or more new species in their urban forest, 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. Prior to selecting or deselecting trees on the basis of RPI alone, managers are encouraged to take into account the age distribution of the species, among other factors. A species that has a 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. The individuals of this species may have produced substantial benefits over the years and should continue to be considered when making determinations for future planting. A complete table, with RPI values for all species, is included in Appendix C.

The RPI value can also help 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, it helps 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. Tree Species Which May Be Underused, Based on RPI

Species	RPI	# of Trees	% of Pop.
Quercus virginiana	**1.00**	124	1.14
Acacia farnesiana	**1.11**	298	2.73
Pinus roxburghii	**1.05**	20	0.18

Replacement Value

The current value of North Las Vegas' inventoried tree resource is approximately $28.1 million. The community forest is a public asset which, when properly cared for, has the potential to appreciate in value as the trees mature over time. Replacement value accounts for the historical investment in trees over their lifetime. 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).

Replacement of the inventoried population of North Las Vegas' trees would cost nearly $28 Million.

To replace North Las Vegas' current inventoried tree population of 10,910 trees with trees of similar size, species, and condition would cost more than $23.9 million (Table 5). The average replacement value per tree is $2,194. *Pinus halepensis* (Aleppo pine) and *Pinus eldarica* (Mondale pine) are the most valuable populations, representing $13.8 million and 50% of the overall replacement value, but just 20% of the inventoried population. A complete table, listing replacement value for all species, is included in Appendix C.

On a per-tree basis, *Ulmus pumila* (Siberian elm, $11,027.06) and *Pinus halepensis* (Aleppo pine, $10,338.18/tree) have the highest average replacement values. The high value of each of these species reinforces their importance to the City. Many of the highest valued species are large and medium-stature trees with large canopies and are therefore likely to have high importance values as well. Conversely, smaller statured trees have average values of around $300 per tree, including *Olea Europaea* 'Swan Hill' (swan hill olive, $320/tree) and *Lagerstroemia indica* (crape myrtle, $287/tree).

North Las Vegas' public trees represent a vital component of the City's infrastructure and a public asset valued at approximately $28.1 million—an asset that, with proper care and maintenance, will increase in value over time. Distinguishing replacement value from the value of annual benefits produced by North Las Vegas' inventoried public trees is very important. Annual benefits are examined in Chapter 3.

Table 5. Replacement Value of North Las Vegas' Public Trees

Species	DBH Class (in)								Total $	% of Total	% of Pop.
	0-3	3-7	7-13	13-19	19-25	25-31	31-37	37+			
Pinus eldarica	32,036	324,789	2,160,169	1,599,908	352,113	98,550	0	0	**4,567,566**	16.28	12.17
Fraxinus velutina 'Fan-Tex'	75,629	596,609	1,235,488	301,327	76,265	110,460	0	0	**2,395,778**	8.54	11.36
Pinus halepensis	469	41,599	1,202,377	4,659,177	2,759,829	544,594	106,657	0	**9,314,702**	33.20	8.26
Washingtonia robusta	4,935	2,675	63,784	58,387	1,842	0	0	0	**131,623**	0.47	4.72
Prosopis chilensis	41,882	189,819	182,445	61,776	0	0	0	0	**475,921**	1.70	4.48
Acacia stenophylla	58,380	241,900	242,148	14,349	0	0	0	0	**556,776**	1.98	4.39
Vitex agnus-castus	86,790	70,942	63,213	54,864	0	30,826	0	0	**306,634**	1.09	4.31
Parkinsonia x 'Desert Museum'	46,265	161,028	90,304	0	0	0	0	0	**297,596**	1.06	3.57
Chilopsis linearis	49,748	147,520	57,192	0	0	0	0	0	**254,460**	0.91	3.56
Ulmus parvifolia	12,842	270,795	155,189	0	0	0	0	0	**438,826**	1.56	3.23
Rhus lancea	23,428	172,658	352,853	34,606	0	0	0	0	**583,545**	2.08	3.09
Pistacia chinensis	23,877	155,045	438,804	25,979	0	0	0	0	**643,705**	2.29	2.79
Acacia farnesiana	24,362	294,035	125,189	18,402	0	0	0	0	**461,989**	1.65	2.73
Chiltalpa tashkentensis	23,185	143,583	77,260	10,129	0	0	0	0	**254,157**	0.91	2.57
Olea europaea	19,814	152,350	319,596	57,370	24,481	0	0	0	**573,612**	2.04	2.28

Species	DBH Class (in)								Total $	% of Total	% of Pop.
	0-3	3-7	7-13	13-19	19-25	25-31	31-37	37+			
Prosopis torreyana	10,480	152,529	279,272	30,386	0	0	0	0	**472,667**	1.68	2.25
Cercidium praecox	28,455	74,431	25,753	0	0	0	0	0	**128,640**	0.46	1.85
Prosopis velutina	4,749	87,795	478,112	209,998	24,481	0	0	0	**805,134**	2.87	1.60
Sophora secundiflora	30,241	7,931	4,108	0	0	0	0	0	**42,280**	0.15	1.51
Gleditsia triacanthos	9,700	29,593	114,783	90,847	46,643	0	0	0	**291,566**	1.04	1.42
Parkinsonia florida	1,889	107,667	356,341	81,185	0	0	0	0	**547,082**	1.95	1.40
Morus alba	1,600	2,961	50,381	175,941	332,073	246,877	43,003	0	**852,837**	3.04	1.35
Prosopis glandulosa	17,289	103,401	37,172	31,391	0	0	0	0	**189,254**	0.67	1.34
Fraxinus angustifolia	9,117	63,159	165,222	53,175	0	0	0	0	**290,673**	1.04	1.24
Quercus virginiana	3,801	89,460	132,111	10,129	0	0	0	0	**235,501**	0.84	1.14
Other Trees	82,560	284,584	707,986	911,251	569,482	223,609	165,048	0	**2,953,445**	10.49	11.40
Citywide total	**$723,524**	**$3,968,859**	**$9,117,253**	**$8,490,577**	**$4,187,209**	**$1,254,916**	**$314,709**	**$ 0.00**	**$28,065,970**	**100%**	**100%**

Chapter 3: Urban Forest Resource Benefits

Trees are important to North Las Vegas. 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, working ceaselessly to provide benefits back to the community. However, the question remains: are the collective benefits worth the costs of management? In other words, are trees a good investment for North Las Vegas? 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 North Las Vegas' inventoried urban forest. While the annual benefits produced by the urban forest can be substantial, it is important to recognize that the greatest benefits from the urban forest 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 North Las Vegas' current inventory data 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 management decisions can be made (Maco and McPherson, 2003). A discussion on the methods used to 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 North Las Vegas from both the shading and climate effects of inventoried trees is equal to 508 MWh (valued at $34,097) and 3,607 therms ($2,328), for a total retail savings of approximately $36,425 and an average of $3.34 per tree (Table 6). *Morus alba* (white mulberry), which represents 1.4% of the population, is providing 4.7% of the energy benefits and the highest per-tree benefit ($11.70/tree). Similarly, *Pinus halepensis* (Aleppo pine), which represents just 8.3% of the population, is providing 20.4% of the total energy benefits and the next highest per-tree benefit of $8.24. Together, the populations of *Pinus eldarica* (Mondale pine) and *Fraxinus velutina* 'Fan-Tex' (Fan-Tex ash) are providing 25% of the overall energy benefits while comprising just 24% of the population (Table 14).

Small stature trees are less able to provide electricity and natural gas reductions. On a per-tree basis, *Chilopsis linearis* (desert willow, $0.85/tree) and *Sophora secundiflora* (Texas mountain laurel, $0.54/tree) provide the lowest benefits. Although these two species account for 5.1% of the urban forest, they are providing only 1.2% of the overall energy benefits.

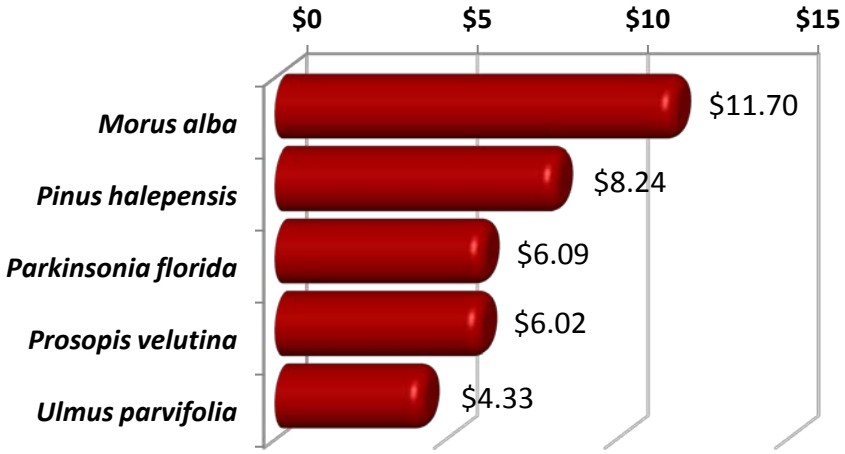


Figure 6. Annual Electricity and Natural Gas Benefits - Top Five Species

Table 6. Annual Electric and Natural Gas Benefits from North Las Vegas' Inventoried Public Trees

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	% of Pop.	% of Total $	Avg. $/tree
Pinus eldarica	67.8	4,549.57	426.9	275.54	**4,825.11**	12.2	13.3	3.63
Fraxinus velutina 'Fan-Tex'	59.8	4,012.62	446.0	287.89	**4,300.50**	11.4	11.8	3.47
Pinus halepensis	104.4	7,003.46	651.1	420.31	**7,423.77**	8.3	20.4	8.24
Washingtonia robusta	7.1	477.76	57.3	36.98	**514.74**	4.7	1.4	1.00
Prosopis chilensis	15.9	1,065.32	124.5	80.37	**1,145.70**	4.5	3.2	2.34
Acacia stenophylla	9.5	636.28	77.1	49.79	**686.07**	4.4	1.9	1.43
Vitex agnus-castus	7.3	489.06	64.0	41.33	**530.39**	4.3	1.5	1.13
Parkinsonia x 'Desert Museum'	7.7	515.63	65.8	42.50	**558.12**	3.6	1.5	1.43
Chilopsis linearis	4.5	303.93	40.2	25.92	**329.85**	3.6	0.9	0.85
Ulmus parvifolia	21.2	1,423.49	157.7	101.82	**1,525.30**	3.2	4.2	4.33
Rhus lancea	9.7	650.32	76.4	49.33	**699.64**	3.1	1.9	2.08
Pistacia chinensis	10.8	727.13	83.9	54.16	**781.30**	2.8	2.1	2.57
Acacia farnesiana	7.7	516.77	64.0	41.34	**558.11**	2.7	1.5	1.87
Chitalpa tashkentensis	6.4	432.65	54.1	34.94	**467.59**	2.6	1.3	1.67
Olea europaea	5.2	346.11	41.8	26.98	**373.09**	2.3	1.0	1.50
Prosopis torreyana	8.9	593.85	70.1	45.28	**639.12**	2.3	1.8	2.60
Cercidium praecox	3.9	263.11	32.7	21.08	**284.19**	1.9	0.8	1.41
Prosopis velutina	14.7	986.73	103.6	66.86	**1,053.60**	1.6	2.9	6.02
Sophora secundiflora	1.2	82.65	10.9	7.04	**89.69**	1.5	0.3	0.54
Gleditsia triacanthos	7.3	492.62	52.3	33.76	**526.38**	1.4	1.5	3.40
Parkinsonia florida	13.0	870.88	93.2	60.15	**931.02**	1.4	2.6	6.09
Morus alba	24.0	1,608.02	172.4	111.28	**1,719.30**	1.4	4.7	11.70
Prosopis glandulosa	3.9	264.27	31.8	20.51	**284.79**	1.3	0.8	1.95
Fraxinus angustifolia	6.8	453.28	50.1	32.33	**485.61**	1.2	1.3	3.60
Quercus virginiana	5.2	346.10	37.6	24.26	**370.36**	1.1	1.0	2.99
Other Trees	74.3	4,985.13	521.2	336.46	**5,321.59**	11.4	14.6	4.28
Citywide Total	**508.1**	**$34,097**	**3,607**	**$2,328**	**$36,425**	**100%**	**100%**	**$3.34**

Atmospheric Carbon Dioxide Reduction

As environmental awareness continues to increase, governments are paying particular attention to global warming and the effects of greenhouse gas emissions. Two national policy options are currently under debate: the establishment of a carbon tax, and a greenhouse gas cap-and-trade system, aimed at the reduction of atmospheric carbon dioxide (CO_2) and other greenhouse gases. A carbon tax would place a tax burden on each unit of greenhouse gas emission and would require regulated entities to pay for their level of emissions. Alternatively, in a cap-and-trade system, an upper limit (or cap) is placed on global (federal, regional, or other jurisdiction) levels of greenhouse gas emissions and the regulated entities would be required to either reduce emissions to required limits or purchase emissions allowances in order to meet the cap (Williams and others, 2007).

The idea that carbon credits are a commodity that can be exchanged for financial gain is based on the growth of emerging carbon markets. 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 greenhouse gas (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 North Las Vegas' urban forest resource may or may not qualify for carbon-offset credits or be traded in the open market, the City's inventoried 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 carbon dioxide (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, North Las Vegas' inventoried urban forest has sequestered a total of 1,694 tons of carbon dioxide (CO_2), valued at $25,409[2]. Annually, this tree resource directly sequesters 189 tons of CO_2, valued at $2,836, into woody and foliar biomass. Accounting for estimated CO_2 emissions from tree decomposition (-13.6 tons), tree related maintenance activity (-2.6 tons), and avoided CO_2 (253.9 tons), North Las Vegas' trees provide an annual net reduction in atmospheric CO_2 of 426.9 tons, valued at $6,403, with an average of $0.59 per tree, reflected by the negative numbers in decomposition and maintenance release in Table 7.

Morus alba (white mulberry, $1.82/tree) and *Pinus halepensis* (Aleppo pine, $1.58/tree) are currently providing the highest per tree benefit (Figure 7). *Pinus halepensis* (Aleppo pine) is providing the greatest percentage of overall benefits at 22.2% due to its larger size and prevalence in the population (8.3%).

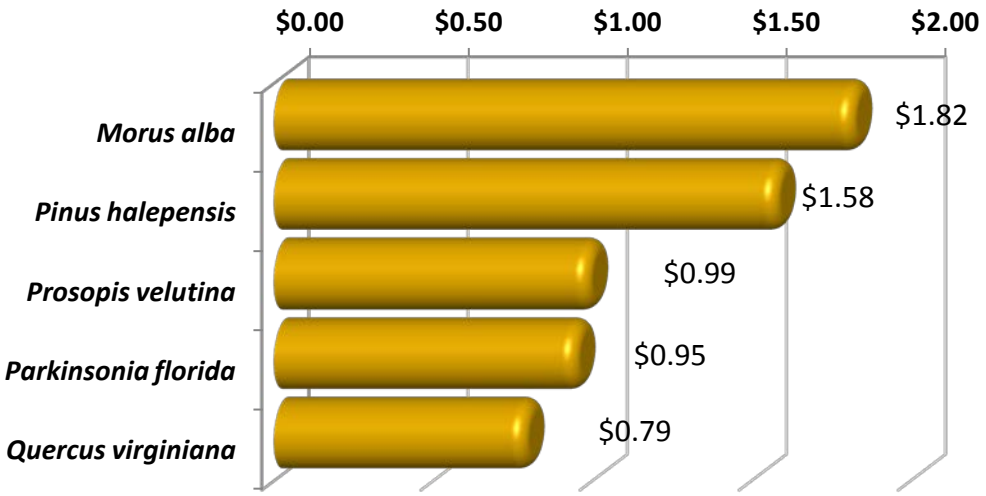


Figure 7. Annual Reduction of CO_2 - Top Five species

[2] Based on i-Tree *Streets* default value of $15 per ton. Market value may vary.

Table 7. Annual CO_2 Reduction Benefits Provided by North Las Vegas' Inventoried Public Trees

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
Morus alba	14,524	108.93	- 2,716.3	- 184.5	- 21.76	23,952	179.64	35,576	**266.82**	1.4	4.17	1.82
Pinus halepensis	93,225	699.19	- 7,304.7	- 983.0	- 62.16	104,320	782.40	189,258	**1,419.43**	8.3	22.17	1.58
Prosopis velutina	8,940	67.05	- 428.3	- 97.6	- 3.94	14,698	110.23	23,112	**173.34**	1.6	2.71	0.99
Parkinsonia florida	6,776	50.82	- 285.8	- 77.8	- 2.73	12,972	97.29	19,384	**145.38**	1.4	2.27	0.95
Quercus virginiana	8,243	61.82	- 332.8	- 50.9	- 2.88	5,155	38.67	13,015	**97.61**	1.1	1.52	0.79
Ulmus parvifolia	9,060	67.95	- 308.1	- 117.1	- 3.19	21,204	159.03	29,839	**223.79**	3.2	3.50	0.64
Gleditsia triacanthos	6,455	48.42	- 403.8	- 68.3	- 3.54	7,338	55.03	13,321	**99.91**	1.4	1.56	0.64
Fraxinus angustifolia	4,399	32.99	- 162.1	- 51.2	- 1.60	6,752	50.64	10,937	**82.03**	1.2	1.28	0.61
Fraxinus velutina 'Fan-Tex'	39,422	295.67	- 1,516.8	- 461.0	- 14.83	59,770	448.28	97,215	**729.11**	11.4	11.39	0.59
Pinus eldarica	37,575	281.81	- 3,415.0	- 815.5	- 31.73	67,768	508.26	101,113	**758.35**	12.2	11.84	0.57
Prosopis torreyana	10,442	78.31	- 560.0	- 97.7	- 4.93	8,846	66.34	18,630	**139.72**	2.3	2.18	0.57
Prosopis chilensis	11,303	84.77	- 317.4	- 140.1	- 3.43	15,869	119.01	26,714	**200.35**	4.5	3.13	0.41
Acacia farnesiana	8,460	63.45	- 338.3	- 90.1	- 3.21	7,698	57.73	15,729	**117.97**	2.7	1.84	0.40
Pistacia chinensis	5,293	39.70	- 251.6	- 105.7	- 2.68	10,831	81.23	15,767	**118.25**	2.8	1.85	0.39
Chitalpa tashkentensis	6,997	52.48	- 278.6	- 75.1	- 2.65	6,445	48.33	13,088	**98.16**	2.6	1.53	0.35
Prosopis glandulosa	2,948	22.11	- 72.7	- 37.6	- 0.83	3,937	29.52	6,774	**50.81**	1.3	0.79	0.35
Parkinsonia x 'Desert Museum'	8,111	60.83	- 288.7	- 90.4	- 2.84	7,681	57.60	15,412	**115.59**	3.6	1.81	0.30
Rhus lancea	3,581	26.86	- 155.5	- 119.2	- 2.06	9,687	72.65	12,993	**97.45**	3.1	1.52	0.29
Washingtonia robusta	13,374	100.31	- 2,503.8	- 440.3	- 22.08	7,117	53.37	17,547	**131.60**	4.7	2.06	0.26
Olea europaea	3,772	28.29	- 191.2	- 92.9	- 2.13	5,156	38.67	8,644	**64.83**	2.3	1.01	0.26
Vitex agnus-castus	7,454	55.91	- 317.8	- 85.5	- 3.02	7,285	54.64	14,336	**107.52**	4.3	1.68	0.23
Cercidium praecox	1,946	14.59	- 54.6	- 40.5	- 0.71	3,919	29.39	5,770	**43.27**	1.9	0.68	0.21
Acacia stenophylla	3,394	25.46	- 121.4	- 127.8	- 1.87	9,478	71.08	12,623	**94.67**	4.4	1.48	0.20
Chilopsis linearis	2,436	18.27	- 9.4	- 84.3	- 0.70	4,527	33.95	6,869	**51.52**	3.6	0.80	0.13
Sophora secundiflora	343	2.57	- 5.7	- 21.6	- 0.21	1,231	9.23	1,547	**11.60**	1.5	0.18	0.07
Other Trees	59,643	447.32	- 4,762.4	- 649.0	- 40.59	74,256	556.92	128,488	**963.66**	11.4	15.05	0.77
Citywide Total	**378,118**	**$2,836**	**- 27,103**	**- 5,205**	**-$242.31**	**507,890**	**$3,809**	**853,700**	**$6,403**	**100%**	**100%**	**$0.59**

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 (0_3) levels

The Clark County Department of Air Quality (CCDAQ) measures air pollution and provides data on the number of days per year that federal pollution standards are exceeded.

PM_{10} is particulate matter in the air that measures less than 10 micrometers, smaller than the width of a single human hair. PM_{10} pollution can cause respiratory problems for local residents. CCDAQ reports that air quality in Clark County exceeded the state 8-hour PM_{10} standard of 150 µg/m3 for only 1 day in 2012.

Ozone (O_3) is another air pollutant that is harmful to human health. Between 2003 and 2012, the Federal 8-hour standard (0.075 ppm) for ground level (O_3) was exceeded 91 days, an average of 9.1 days per year (Table 8) (CCDAQ, 2013).

Table 8. Number of Days Exceeding Federal Ground-Level Ozone

Year	Ozone > Federal 2012 8-hour Standard
2012	19
2011	9
2010	1
2009	5
2008	10
2007	17
2006	8
2005	8
2004	4
2003	10
Average	**9.1**

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 can 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, approximately 1,347 pounds of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), small particulate matter (PM_{10}), and ozone (O_3) are intercepted or absorbed by the inventoried trees in North Las Vegas, for a value of $7,051 (Table 9). As a population, *Pinus eldarica* (Mondale pine, 228.6 lbs.) and *Pinus halepensis* (Aleppo pine, 205.9 lbs) are the greatest contributors to pollutant deposition and interception, accounting for approximately 32% of total 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, 0.87 tons of pollutants, valued at $16,100, are avoided annually through the shading effects of North Las Vegas' inventoried trees.

BVOC Emissions

Biogenic volatile organic compound (BVOC) emissions from trees, which negatively affect air quality, must also be considered. Approximately 0.7 tons of BVOCs are emitted annually from North Las Vegas' inventoried trees, offsetting the total air quality benefit by -$5,780. *Quercus virginiana* (Southern live oak) is the heaviest per tree emitter of BVOCs (-0.98 lbs/tree), accounting for 8.4% of BVOC emissions, while comprising just 1.1% of the population. *Morus alba* (white mulberry, -0.49 lbs/tree) and *Pistacia chinensis* (Chinese pistache, -0.37 lbs/tree) also contribute substantial BVOCs. For these three species, the benefits from interception, deposition, and avoidance of air pollutants (NO_2, PM_{10}, SO_2, and VOCs) are not enough to offset their BVOC emissions, and their per tree net impact on air quality is negative.

Net Air Quality Improvement

The net value of air pollutants removed, avoided, and released by North Las Vegas' inventoried public tree population is $17,372 annually. The average net benefit per tree is $1.59. 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, *Morus alba* (white mulberry, $6.39/tree) and *Pinus halepensis* (Aleppo pine, $3.59/tree) currently produce the greatest per tree net air quality improvements (Figure 8). However, due in part to its established age distribution and high prevalence in the population (8.26%), *Pinus halepensis* (Aleppo pine) account for the greatest air quality improvements (19%) in terms of total benefits by species, collectively removing 273 lbs of pollutants at a net value of $3,233.41.

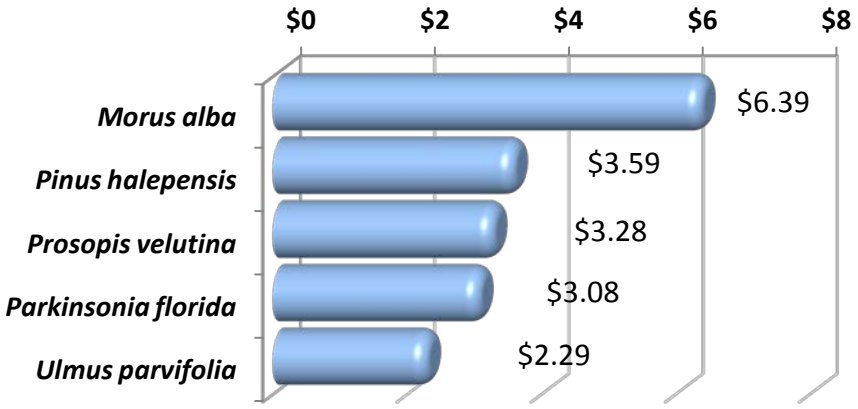


Figure 8. Annual Improvement to Air Quality - Top Five Species

Urban trees Improve air quality in five fundamental ways, including absorption of ozone and nitrogen dioxide.

Table 9. Annual Air Quality Improvements Provided by North Las Vegas' Inventoried Public Trees

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
Pinus eldarica	84.3	46.0	89.0	9.3	1,200.69	122.4	6.2	1.1	104.8	2,176.55	- 105.0	- 420.04	358.0	**2,957.19**	12.17	2.23
Fraxinus velutina 'Fan-Tex'	49.7	23.9	55.8	4.9	706.80	106.8	5.5	1.0	91.2	1,896.11	- 98.2	- 392.83	240.6	**2,210.08**	11.36	1.78
Pinus halepensis	70.1	38.2	89.9	7.7	1,093.47	184.9	9.4	1.6	158.3	3,288.24	- 287.1	- 1,148.30	273.1	**3,233.41**	8.26	3.59
Washingtonia robusta	17.5	9.5	16.6	1.9	237.66	12.9	0.7	0.1	11.0	229.04	- 130.1	- 520.54	- 59.9	**- 53.84**	4.72	- 0.10
Prosopis chilensis	9.9	4.7	12.2	1.0	147.49	28.4	1.5	0.3	24.2	503.75	- 26.0	- 104.00	56.2	**547.25**	4.48	1.12
Acacia stenophylla	5.3	2.9	7.4	0.6	86.04	17.0	0.9	0.2	14.5	300.70	0.0	0.00	48.6	**386.74**	4.39	0.81
Vitex agnus-castus	7.0	3.4	7.6	0.7	97.94	13.1	0.7	0.1	11.1	231.27	- 26.4	- 105.58	17.2	**223.63**	4.31	0.48
Parkinsonia x 'Desert Museum'	6.7	3.2	7.5	0.7	95.11	13.8	0.7	0.1	11.7	244.02	- 27.8	- 111.04	16.7	**228.10**	3.57	0.59
Chilopsis linearis	1.4	0.4	1.7	0.1	18.54	8.1	0.4	0.1	6.9	143.82	- 34.2	- 136.90	- 15.2	**25.46**	3.56	0.07
Ulmus parvifolia	9.2	3.5	11.5	0.7	131.66	38.1	1.9	0.3	32.5	675.37	0.0	0.00	97.8	**807.03**	3.23	2.29
Rhus lancea	6.9	3.8	8.8	0.8	107.60	17.3	0.9	0.2	14.8	307.64	0.0	0.00	53.5	**415.24**	3.09	1.23
Pistacia chinensis	10.7	4.1	10.0	0.9	132.83	19.5	1.0	0.2	16.6	345.63	- 115.1	- 460.58	- 52.2	**17.89**	2.79	0.06
Acacia farnesiana	7.6	3.7	8.2	0.8	106.03	13.9	0.7	0.1	11.8	245.59	- 28.8	- 115.15	17.9	**236.47**	2.73	0.79
Chitalpa tashkentensis	6.3	3.0	6.8	0.6	87.72	11.6	0.6	0.1	9.9	204.86	- 23.8	- 95.32	15.0	**197.27**	2.57	0.70
Olea europaea	4.3	2.3	5.2	0.5	64.99	9.2	0.5	0.1	7.9	163.95	- 4.3	- 17.32	25.6	**211.62**	2.28	0.85
Prosopis torreyana	12.1	5.8	11.9	1.2	162.14	15.9	0.8	0.1	13.5	281.60	- 34.6	- 138.41	26.8	**305.33**	2.25	1.24
Cercidium praecox	1.9	0.9	2.6	0.2	29.98	7.0	0.4	0.1	6.0	124.30	- 11.1	- 44.40	7.9	**109.88**	1.85	0.54
Prosopis velutina	14.6	7.0	15.6	1.5	203.02	26.3	1.3	0.2	22.5	466.66	- 23.8	- 95.17	65.2	**574.51**	1.60	3.28
Sophora secundiflora	0.2	0.1	0.6	0.0	5.40	2.2	0.1	0.0	1.9	39.03	0.0	0.00	5.2	**44.43**	1.51	0.27
Gleditsia triacanthos	7.8	3.4	7.6	0.7	100.77	13.1	0.7	0.1	11.2	233.37	0.0	0.00	44.6	**334.14**	1.42	2.16
Parkinsonia florida	13.2	6.4	14.0	1.3	183.37	23.2	1.2	0.2	19.8	412.14	- 31.2	- 124.91	48.2	**470.60**	1.40	3.08
Morus alba	48.9	13.3	32.1	3.0	487.92	41.6	2.1	0.4	35.5	738.30	- 71.9	- 287.59	105.0	**938.63**	1.35	6.39
Prosopis glandulosa	2.2	1.0	2.8	0.2	33.23	7.0	0.4	0.1	6.0	124.90	- 6.6	- 26.42	13.1	**131.71**	1.34	0.90
Fraxinus angustifolia	5.3	2.6	6.1	0.5	76.56	12.1	0.6	0.1	10.3	214.52	- 10.8	- 43.22	26.9	**247.86**	1.24	1.84
Quercus virginiana	2.5	1.4	3.6	0.3	41.33	9.3	0.5	0.1	7.9	164.74	- 121.1	- 484.24	- 95.6	**- 278.17**	1.14	- 2.24
Other Trees	107.4	51.5	102.4	10.4	1,413.17	132.0	6.7	1.2	112.8	2,343.93	- 226.9	- 907.77	297.5	**2,849.34**	11.40	2.29
Citywide Total	**513.1**	**246.2**	**537.4**	**50.3**	**$7,051**	**906.58**	**46.26**	**8.16**	**774.74**	**$16,100**	**- 1,445**	**-$5,780**	**1,638**	**$17,372**	**100%**	**$1.59**

Stormwater Runoff Reductions

Rainfall interception by trees can reduce 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 can 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.

North Las Vegas' inventoried trees intercept 3,480,958 gallons of stormwater annually for an average of 319 gallons per tree (Table 10). The total value of this benefit to the City is $16,710, an average of $1.53 per tree. *Pinus halepensis* (Aleppo pine) are currently providing the greatest per tree benefit of $5.50 (Figure 9) as well as the greatest percentage of overall benefits (29.7%).

As the trees grow, their stormwater benefits often improve, but some species will realize more substantial benefits than others will. Many of the tree species currently demonstrating very low benefits, including *Chilopsis linearis* (desert willow, $0.18/tree) and *Sophora secundiflora* (Texas mountain laurel, $0.31/tree) are small stature trees. As such, their benefits will not increase much over time. However, other trees with currently low benefits, such as *Pistacia chinensis* (Chinese pistache, $0.74/tree), young populations of medium-stature species, will realize increasing benefits as their canopies mature.

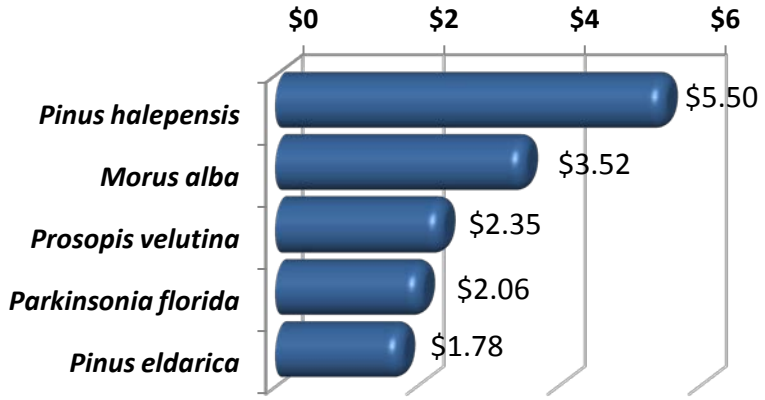


Figure 9. Annual Reduction in Stormwater Runoff - Top Five Species

Table 10. Annual Stormwater Runoff Reduction Benefits Provided by North Las Vegas' Inventoried Public Trees

Species	Total Rainfall Interception (Gal)	Total ($)	% of Pop.	% of Total $	Avg. $/tree
Pinus halepensis	1,031,998	4,953.93	8.3	**29.65**	5.50
Pinus eldarica	492,464	2,363.99	12.2	**14.15**	1.78
Fraxinus velutina 'Fan-Tex'	352,469	1,691.97	11.4	**10.13**	1.37
Morus alba	107,747	517.22	1.4	**3.10**	3.52
Prosopis chilensis	93,823	450.38	4.5	**2.70**	0.92
Ulmus parvifolia	87,278	418.97	3.2	**2.51**	1.19
Prosopis velutina	85,514	410.50	1.6	**2.46**	2.35
Acacia stenophylla	73,526	352.95	4.4	**2.11**	0.74
Rhus lancea	72,328	347.20	3.1	**2.08**	1.03
Parkinsonia florida	65,707	315.42	1.4	**1.89**	2.06
Washingtonia robusta	59,827	287.19	4.7	**1.72**	0.56
Gleditsia triacanthos	50,236	241.15	1.4	**1.44**	1.56
Prosopis torreyana	47,210	226.62	2.3	**1.36**	0.92
Pistacia chinensis	46,956	225.41	2.8	**1.35**	0.74
Acacia farnesiana	40,723	195.48	2.7	**1.17**	0.66
Parkinsonia x 'Desert Museum'	40,242	193.18	3.6	**1.16**	0.50
Fraxinus angustifolia	39,195	188.15	1.2	**1.13**	1.39
Vitex agnus-castus	38,455	184.60	4.3	**1.10**	0.39
Olea europaea	37,461	179.82	2.3	**1.08**	0.72
Quercus virginiana	34,087	163.63	1.1	**0.98**	1.32
Chitalpa tashkentensis	33,946	162.95	2.6	**0.98**	0.58
Prosopis glandulosa	23,643	113.49	1.3	**0.68**	0.78
Cercidium praecox	21,669	104.02	1.9	**0.62**	0.51
Chilopsis linearis	14,759	70.85	3.6	**0.42**	0.18
Sophora secundiflora	10,826	51.97	1.5	**0.31**	0.31
Other Trees	478,866	2,298.72	11.4	**13.76**	1.85
Citywide Total	**3,480,958**	**$16,710**	**100%**	**100%**	**$1.53**

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 associated with property value increases and other less tangible benefits is $287,746, an average of $26.37 per tree (Table 11). Tree species that produce the highest average per tree aesthetic benefits include *Pinus halepensis* (Aleppo pine, $67.98) and *Prosopis velutina* (velvet mesquite, $44.95).

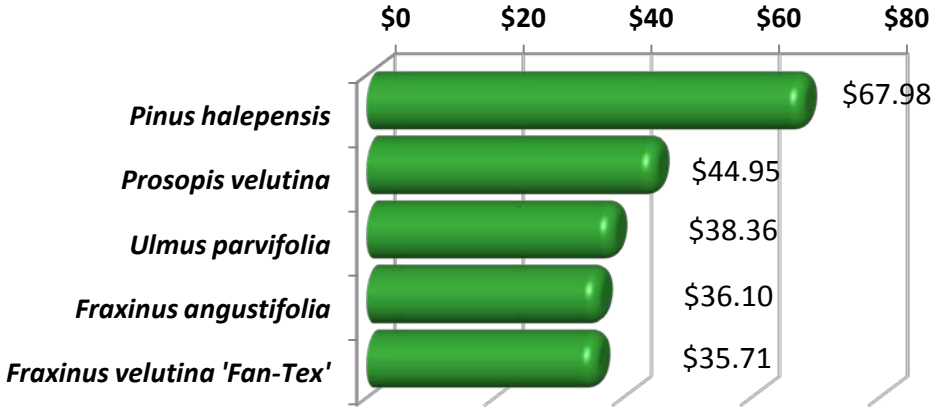


Figure 10. Annual Increase in Property and Socioeconomic Values - Top Five Species

Table 11. Annual Property Value, Aesthetic, and Socioeconomic Benefits Provided by North Las Vegas' Inventoried Tree Resource

Species	Total ($)	% of Pop.	% of Total $	Avg. $/tree
Pinus halepensis	**61,246**	8.26	21.28	67.98
Fraxinus velutina 'Fan-Tex'	**44,249**	11.36	15.38	35.71
Pinus eldarica	**23,206**	12.17	8.06	17.47
Prosopis chilensis	**15,383**	4.48	5.35	31.46
Ulmus parvifolia	**13,503**	3.23	4.69	38.36
Acacia stenophylla	**8,110**	4.39	2.82	16.93
Prosopis velutina	**7,866**	1.60	2.73	44.95
Pistacia chinensis	**6,445**	2.79	2.24	21.20
Rhus lancea	**5,994**	3.09	2.08	17.79
Parkinsonia florida	**5,263**	1.40	1.83	34.40
Gleditsia triacanthos	**5,197**	1.42	1.81	33.53
Fraxinus angustifolia	**4,873**	1.24	1.69	36.10
Vitex agnus-castus	**4,587**	4.31	1.59	9.76
Morus alba	**4,496**	1.35	1.56	30.59
Washingtonia robusta	**4,494**	4.72	1.56	8.73
Prosopis glandulosa	**4,382**	1.34	1.52	30.02
Parkinsonia x 'Desert Museum'	**4,099**	3.57	1.42	10.54
Acacia farnesiana	**3,443**	2.73	1.20	11.55
Olea europaea	**3,391**	2.28	1.18	13.62
Prosopis torreyana	**3,206**	2.25	1.11	13.03
Chilopsis linearis	**3,155**	3.56	1.10	8.13
Chitalpa tashkentensis	**3,098**	2.57	1.08	11.06
Cercidium praecox	**3,056**	1.85	1.06	15.13
Quercus virginiana	**2,992**	1.14	1.04	24.13
Sophora secundiflora	**2,560**	1.51	0.89	15.52
Other Trees	**39,451**	11.40	13.71	31.71
Citywide Total	**$287,746**	**100%**	**100%**	**$26.37**

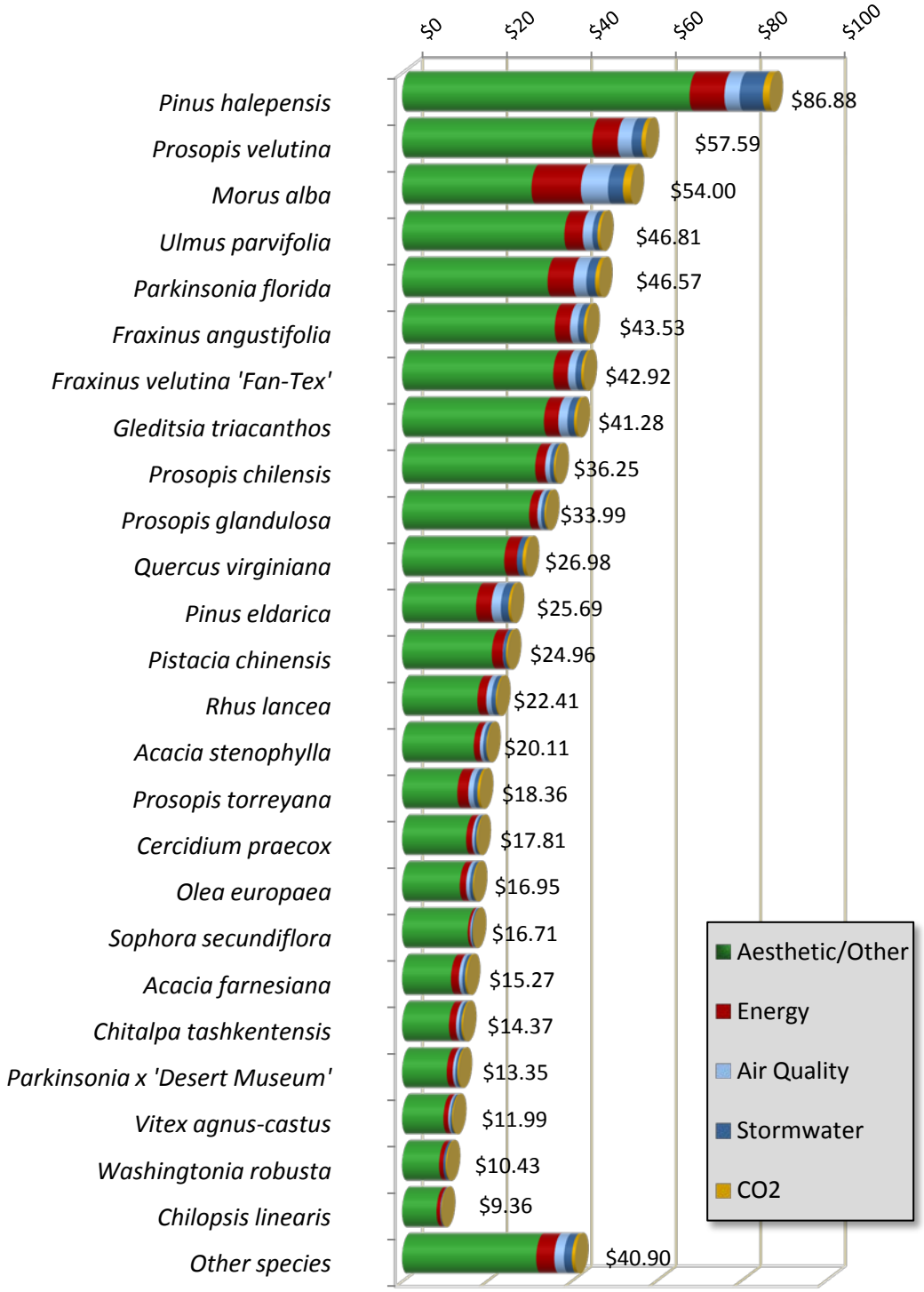


Figure 11. Summary of Annual per Tree Benefits

Table 12. Summary of Current Annual Average per Tree Benefits ($/Tree/yr.) from North Las Vegas' Inventoried Tree Resource

Species	Energy ($/tree)	CO_2 ($/tree)	Air Quality ($/tree)	Stormwater ($/tree)	Aesthetic/ Other ($/tree)	% of Pop.	Total ($/tree)
Pinus halepensis	8.24	1.58	3.59	5.50	67.98	8.26	**86.88**
Prosopis velutina	6.02	0.99	3.28	2.35	44.95	1.60	**57.59**
Morus alba	11.70	1.82	6.39	3.52	30.59	1.35	**54.00**
Ulmus parvifolia	4.33	0.64	2.29	1.19	38.36	3.23	**46.81**
Parkinsonia florida	6.09	0.95	3.08	2.06	34.40	1.40	**46.57**
Fraxinus angustifolia	3.60	0.61	1.84	1.39	36.10	1.24	**43.53**
Fraxinus velutina 'Fan-Tex'	3.47	0.59	1.78	1.37	35.71	11.36	**42.92**
Gleditsia triacanthos	3.40	0.64	2.16	1.56	33.53	1.42	**41.28**
Prosopis chilensis	2.34	0.41	1.12	0.92	31.46	4.48	**36.25**
Prosopis glandulosa	1.95	0.35	0.90	0.78	30.02	1.34	**33.99**
Quercus virginiana	2.99	0.79	- 2.24	1.32	24.13	1.14	**26.98**
Pinus eldarica	3.63	0.57	2.23	1.78	17.47	12.17	**25.69**
Pistacia chinensis	2.57	0.39	0.06	0.74	21.20	2.79	**24.96**
Rhus lancea	2.08	0.29	1.23	1.03	17.79	3.09	**22.41**
Acacia stenophylla	1.43	0.20	0.81	0.74	16.93	4.39	**20.11**
Prosopis torreyana	2.60	0.57	1.24	0.92	13.03	2.25	**18.36**
Cercidium praecox	1.41	0.21	0.54	0.51	15.13	1.85	**17.81**
Olea europaea	1.50	0.26	0.85	0.72	13.62	2.28	**16.95**
Sophora secundiflora	0.54	0.07	0.27	0.31	15.52	1.51	**16.71**
Acacia farnesiana	1.87	0.40	0.79	0.66	11.55	2.73	**15.27**
Chitalpa tashkentensis	1.67	0.35	0.70	0.58	11.06	2.57	**14.37**
Parkinsonia x 'Desert Museum'	1.43	0.30	0.59	0.50	10.54	3.57	**13.35**
Vitex agnus-castus	1.13	0.23	0.48	0.39	9.76	4.31	**11.99**
Washingtonia robusta	1.00	0.26	- 0.10	0.56	8.73	4.72	**10.43**
Chilopsis linearis	0.85	0.13	0.07	0.18	8.13	3.56	**9.36**
Other Trees	4.28	0.77	2.29	1.85	31.71	11.40	**9.19**
Citywide Total	**$3.16**	**$0.55**	**$1.39**	**$1.29**	**$24.21**	**100%**	**$30.60**

Net Benefits and Benefit-Investment Ratio (BIR)

North Las Vegas receives substantial benefits from their public trees; 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 the community tree population. 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 the City's inventoried trees compared to the cost (investment) associated with their management.

North Las Vegas' inventoried trees have beneficial effects on the environment. Approximately 21% ($76,910) of the total annual benefits ($364,656) quantified in this study are environmental services (Table 13). Energy savings ($36,425) account for 47.3% of the annual environmental benefits and 10% of all benefits. The inventoried trees provide $17,372 in air quality benefits, accounting for 22.5% of environmental benefits and 4.8% of all benefits. Stormwater benefits ($16,710) account for 21.7% of environmental benefits and 4.5% of all benefits. Carbon reduction, valued at $6,403, accounts for 8.3% of environmental benefits and 1.8% of all benefits. Annual increases to property value, socioeconomic, and other aesthetic benefits are substantial benefits, accounting for the remaining 79% ($287,746) of all benefits (Table 13).

The total estimated benefits provided by North Las Vegas' inventoried tree resource is $364,656, a value of $33.42 per tree and $1.63 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!**

The total annual quantifiable benefit from North Las Vegas' inventoried public trees is $364,656. When the City's annual tree related expenditure (or investment) of $565,000 in this resource is considered, the net annual benefit (benefits minus investment) to the City is a loss of $200,344. The average net loss for an individual public tree in North Las Vegas is $18.36 and the per capita net loss is $0.89. Based on the inventory of 10,910 public trees, **North Las Vegas is currently receiving $0.65 in benefits for every $1 invested in its urban forest resource** (Table 13).

Considering the relatively young age of North Las Vegas' public urban forest and the dedication to tree planting (currently $20,000/year), a small loss is not unreasonable. As existing trees mature and vacant planting sites are filled, the benefits from this resource will increase and annual planting costs can be reduced. Over time, with proactive and timely management, North Las Vegas' urban forest can contribute positive net benefits to the community. Furthermore, considering the vital importance of trees to the quality of life in the North Las Vegas community, the true value of North Las Vegas' urban forest is incalculable.

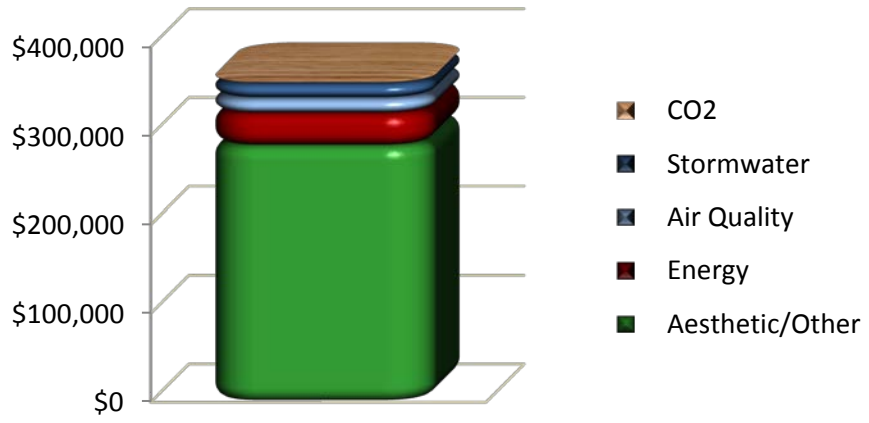


Figure 12. Total Annual Benefits from North Las Vegas' Inventoried Trees

Total Annual Benefits: $364,656
Average Annual per Tree Benefits: $33.42
Annual Value of Benefits per Capita: $1.63

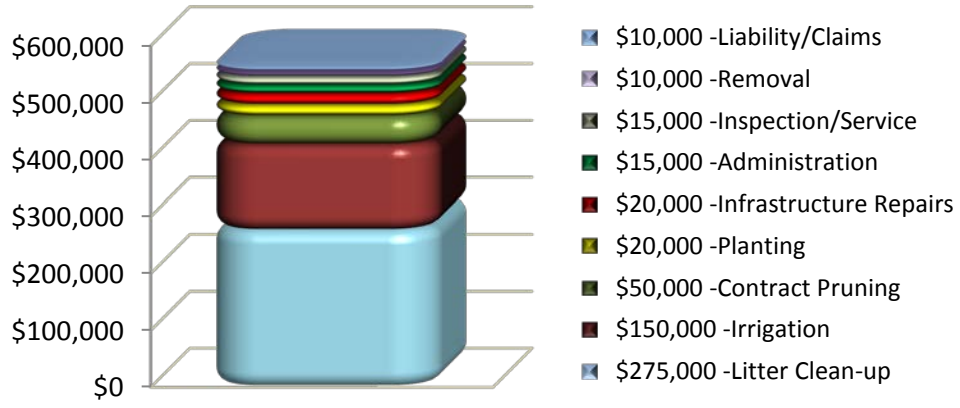


Figure 13. Total Annual Investment to Maintain North Las Vegas' Inventoried Trees

Total Annual Investment: $565,000
Average Annual per Tree Investment: $51.79
Annual Investment per Capita: $2.52

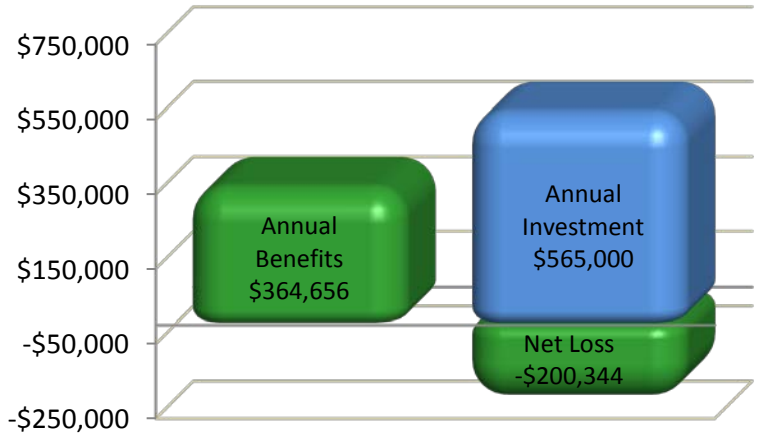


Figure 14. Benefit versus Investment Ratio

Annual Net Loss of North Las Vegas' Inventoried Tree Resource: -$200,344

For EVERY $1 invested in park trees, North Las Vegas receives $0.65 in benefits.

Table 13. Annual Benefit Versus Investment Summary for North Las Vegas' Inventoried Tree Resource

Benefits	Total $	$/tree	$/capita
Energy	36,425	3.34	0.16
CO_2	6,403	0.59	0.03
Air Quality	17,372	1.59	0.08
Stormwater	16,710	1.53	0.07
Aesthetic/Other	287,746	26.37	1.28
Total Benefits	**$364,656**	**$33.42**	**$1.63**
Investment			
Litter Clean-up	275,000	25.21	1.23
Irrigation	150,000	13.75	0.67
Contract Pruning	50,000	4.58	0.22
Planting	20,000	1.83	0.09
Infrastructure Repairs	20,000	1.83	0.09
Administration	15,000	1.37	0.07
Inspection/Service	15,000	1.37	0.07
Removal	10,000	0.92	0.04
Liability/Claims	10,000	0.92	0.04
Total Investment	**$565,000**	**$51.79**	**$2.52**
Net Loss	**-$200,344**	**-$18.36**	**-$0.89**
Benefit-Investment ratio	**$0.65**		

Conclusion

This analysis describes the current structural characteristics of North Las Vegas' inventoried public tree resource using established tree sampling, numerical modeling, and statistical methods to provide a general accounting of the benefits. The analysis provides a "snapshot" of this resource at its current population, structure, and condition. Rather than examining each individual tree, as an inventory does, the resource analysis examines trends and performance measures over the entire urban forest and each of the major species populations within.

North Las Vegas' inventoried are providing quantifiable benefits including energy savings, stormwater runoff reduction, reduction in atmospheric CO_2, and aesthetic benefits. The City's 10,910 inventoried trees are providing $364,656 in annual gross benefits. That is an average of -$18.36 per tree and -$0.89 per capita.

The trees inventoried in this project are relatively young and in fair to good condition with more than 88 different species. Although it is critical to maintain an adequate level of resources to protect and nurture this resource, North Las Vegas' public trees can be expected to provide even greater benefits in the future and for many generations to come. The City can focus resources on maximizing the flow of benefits from the current tree population and maintaining a forward-thinking approach. Based on the resource analysis, Davey Resource Group recommends the following:

- Maintain an appropriate age distribution by continuing to plant new trees to improve long-term resource sustainability and greater canopy coverage. To maximize benefits, focus on medium to large-stature trees where conditions are sustainable.
- Maximize the condition of the existing tree resource through continuing comprehensive tree maintenance and a cyclical pruning schedule.
- Continue annual tree planting efforts with the goal of achieving a 100% stocking rate, utilizing available planting sites identified by the inventory.
- Implement a structural pruning program for young and establishing trees to promote healthy structure, extend life expectancy, and reduce future costs and liability.
- Maintain and update the inventory database.

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.

North Las Vegas' trees are of vital importance to the environmental, social, and economic well-being of the community. North Las Vegas 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 City may use this inventory to take a proactive and forward-looking approach to caring for the community's trees in the future. Updates should be incorporated into the inventory as work is performed. 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. With additional tree planting and proactive management, North Las Vegas' urban forest can be expected to produce an even greater flow of benefits as this resource continues to mature. By maintaining a commitment to planting, maintaining, and preserving these trees, the community will continue to be a healthy, safe, and enjoyable place to live.

Appendix A: Methods and Procedures

Certified arborists collected North Las Vegas' tree inventory, using ArcPad software to assist the inventory arborist in locating the sample plots on the ground and inputting tree attributes (details about each tree's species, size, and condition). The data was formatted for use in i-Tree's public tree population assessment tool, i-Tree *Streets*, a STRATUM Analysis Tool (Streets v 5.0.1; i-Tree v 5.0.6). 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. In order to analyze the economic benefits of North Las Vegas' 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 (North Las Vegas is located in the Southwest Desert 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's tree care investments were derived from the overall annual city budget ($565,000) for tree related expenses.

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. North Las Vegas Benefit Prices Used In This Analysis

Benefits	Price	Unit	Source
Electricity	$0.0671	$/Kwh	Residential rates from NV Energy
Natural Gas	$0.6455	$/Therm	Residential rates from NV Energy
CO_2	$0.0075	$/lb	*Streets* default – Southwest Desert
PM_{10}	$6	$/lb	*Streets* default – Southwest Desert
NO_2	$4	$/lb	*Streets* default – Southwest Desert
SO_2	$15.70	$/lb	*Streets* default – Southwest Desert
VOC	$4	$/lb	*Streets* default – Southwest Desert
Stormwater Interception	$0.0048	$/gallon	*Streets* default – Southwest Desert
Median Home Value	$125,000	$	Submitted by the City of NLV

The i-Tree *Streets* default values (Table 14) from the Southwest Desert Climate Zone were used for all benefit prices except for median home values and electric and natural gas rates. Electric rates and natural gas rates are residential rates from Nevada Energy (NV Energy). Median home value for North Las Vegas was submitted by the City. Using these rates, the magnitude of the benefits provided by the inventoried tree resource was calculated using i-Tree *Streets*. Program budget values used in benefit versus investment ratio calculations were supplied by the City of North Las Vegas.

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Appendix C: Reports

North Las Vegas' Population of Inventoried Trees

Species	DBH Class (in)								Total	% of Pop.
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	>36		
Broadleaf Deciduous Large (BDL)										
Gleditsia triacanthos	64	35	40	13	3	0	0	0	155	1.4
Plantanus occidentalis	1	8	34	1	0	0	0	0	44	0.4
Populus species	1	0	4	6	14	9	3	0	37	0.3
Ulmus pumila	5	1	6	7	3	3	2	0	27	0.2
Platanus wrightii	0	0	2	3	8	0	0	0	13	0.1
Quercus muehlenbergii	3	4	1	0	0	0	0	0	8	0.1
Quecus shumardii	4	0	0	0	0	0	0	0	4	0.0
Ailanthus altissima	2	0	0	0	0	0	0	0	2	0.0
Fraxinus uhdei	1	1	0	0	0	0	0	0	2	0.0
Carya illinoinensis	0	0	1	0	0	0	0	0	1	0.0
Total	**81**	**49**	**88**	**30**	**28**	**12**	**5**	**0**	**293**	**2.7**
Broadleaf Deciduous Medium (BDM)										
Fraxinus velutina	429	515	261	27	4	3	0	0	1,239	11.4
Prosopis chilensis	234	199	50	6	0	0	0	0	489	4.5
Ulmus parvifolia	78	242	32	0	0	0	0	0	352	3.2
Pistacia chinensis	126	101	75	2	0	0	0	0	304	2.8
Parkinsonia florida	9	77	62	5	0	0	0	0	153	1.4
Morus alba	10	5	29	41	41	19	2	0	147	1.3
Fraxinus angustifolia	47	52	32	4	0	0	0	0	135	1.2
Fraxinus velutina	28	23	20	19	8	1	1	0	100	0.9
Robinia ambigua 'Purple Robe'	48	32	0	0	0	0	0	0	80	0.7
Celtis occidentalis	14	26	20	1	0	0	0	0	61	0.6
Parkinsonia aculeata	10	17	20	3	0	0	0	0	50	0.5
Robinia pseudoacacia	17	13	4	4	0	0	0	0	38	0.3
Koelreuteria paniculata	6	12	3	1	2	0	0	0	24	0.2
Melia azedarach	2	2	3	5	1	0	0	0	13	0.1
Fraxinus velutina 'Glabra'	0	0	1	5	0	0	0	0	6	0.1
Total	**1,058**	**1,316**	**612**	**123**	**56**	**23**	**3**	**0**	**3,191**	**29.2**
Broadleaf Deciduous Small (BDS)										
Vitex agnus-castus	388	59	17	5	0	1	0	0	470	4.3
Parkinsonia x 'Desert Museum'	229	140	20	0	0	0	0	0	389	3.6
Chilopsis linearis	243	132	13	0	0	0	0	0	388	3.6
Acacia farnesiana	96	182	19	1	0	0	0	0	298	2.7
Chitalpa tashkentensis	131	130	18	1	0	0	0	0	280	2.6
Prosopis torreyana	54	129	60	3	0	0	0	0	246	2.3
Cercidium praecox	140	56	6	0	0	0	0	0	202	1.9

Species	DBH Class (in)								Total	% of Pop.
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	>36		
Prosopis velutina	21	61	77	15	1	0	0	0	175	1.6
Prosopis glandulosa	75	63	6	2	0	0	0	0	146	1.3
Prunus cerasifera	34	13	0	0	0	0	0	0	47	0.4
Lagerstroemia indica	34	5	0	0	0	0	0	0	39	0.4
Prosopis pubescens	13	2	0	0	0	0	0	0	15	0.1
Tamarix chinensis	9	0	1	1	0	0	0	0	11	0.1
Prunus species	5	3	1	0	0	0	0	0	9	0.1
Malus sylvestris	1	6	1	0	0	0	0	0	8	0.1
Parkinsonia microphylla	5	0	0	0	0	0	0	0	5	0.0
Punica granatum	3	0	0	0	0	0	0	0	3	0.0
Cercis canadensis	1	0	0	0	0	0	0	0	1	0.0
Cercis occindentalis	1	0	0	0	0	0	0	0	1	0.0
Prosopis spp.	0	0	1	0	0	0	0	0	1	0.0
Prunus dulcis	0	1	0	0	0	0	0	0	1	0.0
Prunus persica	1	0	0	0	0	0	0	0	1	0.0
Total	**1,484**	**982**	**240**	**28**	**1**	**1**	**0**	**0**	**2,736**	**25.1**
Broadleaf Evergreen Large (BEL)										
Quercus ilex	19	15	3	0	1	0	0	0	38	0.3
Eucalyptus camaldulensis	0	5	0	0	0	0	0	0	5	0.0
Eucalyptus species	3	0	0	0	0	0	0	0	3	0.0
Eucalyptus microtheca	0	0	0	2	0	0	0	0	2	0.0
Eucalyptus polyanthemos	1	0	0	1	0	0	0	0	2	0.0
Quercus suber	1	1	0	0	0	0	0	0	2	0.0
Grevillea robusta	0	1	0	0	0	0	0	0	1	0.0
Total	**24**	**22**	**3**	**3**	**1**	**0**	**0**	**0**	**53**	**0.5**
Broadleaf Evergreen Medium (BEM)										
Quercus virginiana	18	75	30	1	0	0	0	0	124	1.1
Schinus molle	0	1	8	3	1	0	0	0	13	0.1
Total	**18**	**76**	**38**	**4**	**1**	**0**	**0**	**0**	**137**	**1.3**
Broadleaf Evergreen Small (BES)										
Acacia stenophylla	249	182	47	1	0	0	0	0	479	4.4
Rhus lancea	114	150	70	3	0	0	0	0	337	3.1
Olea europaea	85	101	58	4	1	0	0	0	249	2.3
Sophora secundiflora	157	7	1	0	0	0	0	0	165	1.5
Acacia aneura	63	8	0	0	0	0	0	0	71	0.7
Chamaerops humilis	3	21	31	0	0	0	0	0	55	0.5
Platycladus orientalis	7	25	11	4	1	0	0	0	48	0.4
Pyrus kawakamii	23	6	14	3	0	0	0	0	46	0.4
Acacia constricta	5	18	1	0	0	0	0	0	24	0.2
Olea europaea 'Swan Hill'	18	2	0	0	0	0	0	0	20	0.2
Ligustrum lucidum	6	8	2	1	0	0	0	0	17	0.2
Acacia greggii	10	4	0	0	0	0	0	0	14	0.1

Species	DBH Class (in)								Total	% of Pop.
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	>36		
Prunus caroliniana	6	0	0	0	0	0	0	0	6	0.1
Quercus berberidifolia	2	2	0	0	0	0	0	0	4	0.0
Acacia pendula	0	0	1	1	1	0	0	0	3	0.0
Quercus rugosa	2	1	0	0	0	0	0	0	3	0.0
Yucca brevifolia	0	2	1	0	0	0	0	0	3	0.0
Acacia saligna	0	0	1	0	0	0	0	0	1	0.0
Arbutus unedo	1	0	0	0	0	0	0	0	1	0.0
Callistemon viminalis	1	0	0	0	0	0	0	0	1	0.0
Leucaena retusa	1	0	0	0	0	0	0	0	1	0.0
Myrtus communis	1	0	0	0	0	0	0	0	1	0.0
Total	**754**	**537**	**238**	**17**	**3**	**0**	**0**	**0**	**1,549**	**14.2**
Conifer Evergreen Large (CEL)										
Pinus eldarica	185	344	595	177	23	4	0	0	1,328	12.2
Pinus halepensis	3	36	269	437	138	16	2	0	901	8.3
Pinus pinea	0	1	19	19	6	1	0	0	46	0.4
Cupressus sempervirens	13	8	2	1	0	0	0	0	24	0.2
Pinus roxburghii	1	7	10	2	0	0	0	0	20	0.2
Total	**202**	**396**	**895**	**636**	**167**	**21**	**2**	**0**	**2,319**	**21.3**
Conifer Evergreen Medium (CEM)										
Cupressus leylandii	2	0	2	10	2	0	0	0	16	0.1
Total	**2**	**0**	**2**	**10**	**2**	**0**	**0**	**0**	**16**	**0.1**
Palm Evergreen Large (PEL)										
Phoenix canariensis	0	0	0	29	0	0	1	0	30	0.3
Total	**0**	**0**	**0**	**29**	**0**	**0**	**1**	**0**	**30**	**0.3**
Palm Evergreen Medium (PEM)										
Phoenix dactylifera	0	0	1	15	0	0	0	0	16	0.1
Total	**0**	**0**	**1**	**15**	**0**	**0**	**0**	**0**	**16**	**0.1**
Palm Evergreen Small (PES)										
Washingtonia robusta	28	14	264	203	6	0	0	0	515	4.7
Washingtonia filifera	0	0	4	22	13	14	2	0	55	0.5
Total	**28**	**14**	**268**	**225**	**19**	**14**	**2**	**0**	**570**	**5.2**
Citywide Total	**3,651**	**3,392**	**2,385**	**1,120**	**278**	**71**	**13**	**0**	**10,910**	**100%**

Relative Performance Index (RPI) for North Las Vegas' Inventoried Tree Species

Species	Dead or Dying	Poor	Fair	Good	N/A	RPI	# of Trees	% of Pop.
Pinus eldarica	0.83	2.94	43.15	53.09	0.00	**1.08**	1,328	12.17
Fraxinus velutina 'Fan-Tex'	4.52	11.14	58.51	25.42	0.40	**0.92**	1,239	11.36
Pinus halepensis	1.78	6.10	69.48	22.64	0.00	**0.95**	901	8.26
Washingtonia robusta	0.19	0.58	27.38	71.84	0.00	**1.17**	515	4.72
Prosopis chilensis	1.43	11.04	39.26	48.26	0.00	**1.03**	489	4.48
Acacia stenophylla	0.21	1.67	31.73	66.39	0.00	**1.14**	479	4.39
Vitex agnus-castus	1.06	5.32	39.79	53.83	0.00	**1.08**	470	4.31
Parkinsonia x 'Desert Museum'	0.26	7.20	61.95	30.59	0.00	**0.99**	389	3.57
Chilopsis linearis	1.80	11.08	53.61	33.51	0.00	**0.97**	388	3.56
Ulmus parvifolia	1.42	13.35	65.91	19.32	0.00	**0.91**	352	3.23
Rhus lancea	0.59	4.75	58.75	35.91	0.00	**1.01**	337	3.09
Pistacia chinensis	1.97	13.16	58.55	26.32	0.00	**0.94**	304	2.79
Acacia farnesiana	0.00	2.01	41.61	56.38	0.00	**1.11**	298	2.73
Chitalpa tashkentensis	2.50	13.57	70.00	13.93	0.00	**0.88**	280	2.57
Olea europaea	0.40	1.61	67.07	30.92	0.00	**1.01**	249	2.28
Prosopis torreyana	1.22	8.54	56.50	33.74	0.00	**0.99**	246	2.25
Cercidium praecox	0.99	5.94	51.49	41.58	0.00	**1.03**	202	1.85
Prosopis velutina	1.71	5.71	54.29	38.29	0.00	**1.01**	175	1.60
Sophora secundiflora	0.00	1.82	49.70	48.48	0.00	**1.08**	165	1.51
Gleditsia triacanthos	3.23	20.65	61.29	14.84	0.00	**0.86**	155	1.42
Parkinsonia florida	0.00	6.54	67.97	25.49	0.00	**0.97**	153	1.40
Morus alba	6.80	5.44	70.75	17.01	0.00	**0.89**	147	1.35
Prosopis glandulosa	1.37	6.16	43.15	49.32	0.00	**1.05**	146	1.34
Fraxinus angustifolia	3.70	9.63	42.22	44.44	0.00	**1.00**	135	1.24
Quercus virginiana	0.00	2.42	67.74	29.84	0.00	**1.00**	124	1.14
Fraxinus velutina	10.00	15.00	54.00	21.00	0.00	**0.85**	100	0.92
Robinia ambigua 'Purple Robe'	15.00	23.75	47.50	13.75	0.00	**0.75**	80	0.73
Acacia aneura	0.00	0.00	64.79	35.21	0.00	**1.03**	71	0.65
Celtis occidentalis	0.00	32.79	52.46	14.75	0.00	**0.83**	61	0.56
Washingtonia filifera	0.00	1.82	21.82	76.36	0.00	**1.18**	55	0.50
Chamaerops humilis	0.00	0.00	61.82	38.18	0.00	**1.04**	55	0.50
Parkinsonia aculeata	0.00	8.00	46.00	46.00	0.00	**1.04**	50	0.46
Platycladus orientalis	6.25	8.33	39.58	45.83	0.00	**1.00**	48	0.44
Prunus cerasifera	10.64	40.43	44.68	4.26	0.00	**0.69**	47	0.43
Pyrus kawakamii	4.35	6.52	78.26	10.87	0.00	**0.88**	46	0.42
Pinus pinea	0.00	0.00	84.78	15.22	0.00	**0.96**	46	0.42
Plantanus occidentalis	2.27	13.64	50.00	34.09	0.00	**0.96**	44	0.40
Lagerstroemia indica	5.13	17.95	51.28	25.64	0.00	**0.89**	39	0.36
Robinia pseudoacacia	2.63	28.95	47.37	21.05	0.00	**0.85**	38	0.35
Quercus ilex	10.53	34.21	42.11	13.16	0.00	**0.74**	38	0.35
Populus species	5.41	51.35	35.14	8.11	0.00	**0.70**	37	0.34
Phoenix canariensis	0.00	0.00	3.33	96.67	0.00	**1.26**	30	0.27
Ulmus pumila	7.41	22.22	44.44	25.93	0.00	**0.86**	27	0.25
Acacia constricta	0.00	8.33	75.00	16.67	0.00	**0.93**	24	0.22

Species	Dead or Dying	Poor	Fair	Good	N/A	RPI	# of Trees	% of Pop.
Cupressus sempervirens	4.17	16.67	45.83	33.33	0.00	**0.93**	24	0.22
Koelreuteria paniculata	0.00	12.50	79.17	8.33	0.00	**0.89**	24	0.22
Pinus roxburghii	0.00	10.00	40.00	50.00	0.00	**1.05**	20	0.18
Olea europaea 'Swan Hill'	0.00	0.00	0.00	100.00	0.00	**1.28**	20	0.18
Ligustrum lucidum	5.88	17.65	52.94	23.53	0.00	**0.88**	17	0.16
Cupressus leylandii	0.00	37.50	50.00	12.50	0.00	**0.81**	16	0.15
Phoenix dactylifera	0.00	0.00	12.50	87.50	0.00	**1.23**	16	0.15
Prosopis pubescens	0.00	13.33	66.67	20.00	0.00	**0.93**	15	0.14
Acacia greggii	0.00	7.14	78.57	14.29	0.00	**0.93**	14	0.13
Melia azedarach	0.00	23.08	46.15	30.77	0.00	**0.93**	13	0.12
Schinus molle	0.00	7.69	76.92	15.38	0.00	**0.93**	13	0.12
Platanus wrightii	0.00	30.77	61.54	7.69	0.00	**0.81**	13	0.12
Tamarix chinensis	0.00	0.00	18.18	81.82	0.00	**1.21**	11	0.10
Prunus species	11.11	22.22	55.56	11.11	0.00	**0.78**	9	0.08
Quercus muehlenbergii	0.00	0.00	75.00	25.00	0.00	**1.00**	8	0.07
Malus sylvestris	0.00	12.50	87.50	0.00	0.00	**0.85**	8	0.07
Fraxinus velutina 'Glabra'	0.00	66.67	33.33	0.00	0.00	**0.65**	6	0.05
Prunus caroliniana	0.00	0.00	33.33	66.67	0.00	**1.15**	6	0.05
Eucalyptus camaldulensis	0.00	0.00	0.00	100.00	0.00	**1.28**	5	0.05
Parkinsonia microphylla	0.00	0.00	20.00	80.00	0.00	**1.20**	5	0.05
Quercus berberidifolia	0.00	0.00	100.00	0.00	0.00	**0.90**	4	0.04
Quecus shumardii	0.00	0.00	100.00	0.00	0.00	**0.90**	4	0.04
Acacia pendula	0.00	33.33	66.67	0.00	0.00	**0.78**	3	0.03
Yucca brevifolia	0.00	0.00	66.67	33.33	0.00	**1.03**	3	0.03
Quercus rugosa	0.00	0.00	100.00	0.00	0.00	**0.90**	3	0.03
Eucalyptus species	66.67	0.00	33.33	0.00	0.00	**0.40**	3	0.03
Punica granatum	0.00	0.00	100.00	0.00	0.00	**0.90**	3	0.03
Eucalyptus microtheca	0.00	0.00	100.00	0.00	0.00	**0.90**	2	0.02
Eucalyptus polyanthemos	0.00	0.00	100.00	0.00	0.00	**0.90**	2	0.02
Ailanthus altissima	0.00	0.00	50.00	50.00	0.00	**1.09**	2	0.02
Fraxinus uhdei	0.00	0.00	100.00	0.00	0.00	**0.90**	2	0.02
Quercus suber	0.00	0.00	100.00	0.00	0.00	**0.90**	2	0.02
Myrtus communis	0.00	0.00	0.00	100.00	0.00	**1.28**	1	0.01
Prosopis species	100.00	0.00	0.00	0.00	0.00	**0.15**	1	0.01
Callistemon viminalis	0.00	0.00	100.00	0.00	0.00	**0.90**	1	0.01
Acacia saligna	0.00	0.00	100.00	0.00	0.00	**0.90**	1	0.01
Carya illinoinensis	0.00	0.00	100.00	0.00	0.00	**0.90**	1	0.01
Cercis canadensis	0.00	0.00	100.00	0.00	0.00	**0.90**	1	0.01
Prunus dulcis	0.00	0.00	0.00	100.00	0.00	**1.28**	1	0.01
Leucaena retusa	0.00	0.00	0.00	100.00	0.00	**1.28**	1	0.01
Grevillea robusta	0.00	100.00	0.00	0.00	0.00	**0.53**	1	0.01
Prunus persica	0.00	0.00	0.00	100.00	0.00	**1.28**	1	0.01
Arbutus unedo	0.00	100.00	0.00	0.00	0.00	**0.53**	1	0.01
Cercis occindentalis	0.00	0.00	100.00	0.00	0.00	**0.90**	1	0.01
Citywide Total	**1.89**	**7.82**	**52.25**	**37.99**	**0.05**	**1.00**	**10,910**	**100%**

Replacement Value of North Las Vegas' Inventoried Tree Species

Species	DBH Class (in) 0-3	3-7	7-13	13-19	19-25	25-31	31-37	37+	Total ($)	% of Total	% of Pop.
Pinus eldarica	32,036	324,789	2,160,169	1,599,908	352,113	98,550	0	0	**4,567,566**	16.28	12.17
Fraxinus velutina 'Fan-Tex'	75,629	596,609	1,235,488	301,327	76,265	110,460	0	0	**2,395,778**	8.54	11.36
Pinus halepensis	469	41,599	1,202,377	4,659,177	2,759,829	544,594	106,657	0	**9,314,702**	33.20	8.26
Washingtonia robusta	4,935	2,675	63,784	58,387	1,842	0	0	0	**131,623**	0.47	4.72
Prosopis chilensis	41,882	189,819	182,445	61,776	0	0	0	0	**475,921**	1.70	4.48
Acacia stenophylla	58,380	241,900	242,148	14,349	0	0	0	0	**556,776**	1.98	4.39
Vitex agnus-castus	86,790	70,942	63,213	54,864	0	30,826	0	0	**306,634**	1.09	4.31
Parkinsonia x 'Desert Museum'	46,265	161,028	90,304	0	0	0	0	0	**297,596**	1.06	3.57
Chilopsis linearis	49,748	147,520	57,192	0	0	0	0	0	**254,460**	0.91	3.56
Ulmus parvifolia	12,842	270,795	155,189	0	0	0	0	0	**438,826**	1.56	3.23
Rhus lancea	23,428	172,658	352,853	34,606	0	0	0	0	**583,545**	2.08	3.09
Pistacia chinensis	23,877	155,045	438,804	25,979	0	0	0	0	**643,705**	2.29	2.79
Acacia farnesiana	24,362	294,035	125,189	18,402	0	0	0	0	**461,989**	1.65	2.73
Chiltalpa tashkentensis	23,185	143,583	77,260	10,129	0	0	0	0	**254,157**	0.91	2.57
Olea europaea	19,814	152,350	319,596	57,370	24,481	0	0	0	**573,612**	2.04	2.28
Prosopis torreyana	10,480	152,529	279,272	30,386	0	0	0	0	**472,667**	1.68	2.25
Cercidium praecox	28,455	74,431	25,753	0	0	0	0	0	**128,640**	0.46	1.85
Prosopis velutina	4,749	87,795	478,112	209,998	24,481	0	0	0	**805,134**	2.87	1.60
Sophora secundiflora	30,241	7,931	4,108	0	0	0	0	0	**42,280**	0.15	1.51
Gleditsia triacanthos	9,700	29,593	114,783	90,847	46,643	0	0	0	**291,566**	1.04	1.42
Parkinsonia florida	1,889	107,667	356,341	81,185	0	0	0	0	**547,082**	1.95	1.40
Morus alba	1,600	2,961	50,381	175,941	332,073	246,877	43,003	0	**852,837**	3.04	1.35
Prosopis glandulosa	17,289	103,401	37,172	31,391	0	0	0	0	**189,254**	0.67	1.34
Fraxinus angustifolia	9,117	63,159	165,222	53,175	0	0	0	0	**290,673**	1.04	1.24
Quercus virginiana	3,801	89,460	132,111	10,129	0	0	0	0	**235,501**	0.84	1.14
Fraxinus velutina	4,518	17,246	44,436	101,374	76,256	20,277	14,505	0	**278,612**	0.99	0.92
Robinia ambigua 'Purple Robe'	8,556	33,905	0	0	0	0	0	0	**42,462**	0.15	0.73
Acacia aneura	13,266	9,035	0	0	0	0	0	0	**22,302**	0.08	0.65
Celtis occidentalis	2,014	24,333	86,959	10,129	0	0	0	0	**123,435**	0.44	0.56
Chamaerops humilis	607	3,890	6,593	0	0	0	0	0	**11,091**	0.04	0.50
Washingtonia filifera	0	0	1,818	12,269	9,637	11,963	1,448	0	**37,135**	0.13	0.50
Parkinsonia aculeata	1,634	9,623	36,984	17,560	0	0	0	0	**65,800**	0.23	0.46
Platycladus orientalis	1,499	33,548	44,817	43,891	19,066	0	0	0	**142,821**	0.51	0.44
Prunus cerasifera	4,626	9,864	0	0	0	0	0	0	**14,491**	0.05	0.43
Pinus pinea	0	1,074	81,273	209,325	114,397	30,826	0	0	**436,895**	1.56	0.42
Pyrus kawakamii	3,812	4,599	43,497	21,803	0	0	0	0	**73,711**	0.26	0.42
Plantanus occidentalis	182	6,799	158,868	10,129	0	0	0	0	**175,977**	0.63	0.40

Species	DBH Class (in)								Total ($)	% of Total	% of Pop.
	0-3	3-7	7-13	13-19	19-25	25-31	31-37	37+			
Lagerstroemia indica	7,357	5,277	0	0	0	0	0	0	**12,634**	0.05	0.36
Quercus ilex	3,347	15,208	7,024	0	19,066	0	0	0	**44,645**	0.16	0.35
Robinia pseudoacacia	3,120	12,614	16,054	40,515	0	0	0	0	**72,302**	0.26	0.35
Populus species	192	0	6,978	24,790	80,444	80,909	38,555	0	**231,868**	0.83	0.34
Phoenix canariensis	0	0	0	62,073	0	0	3,883	0	**65,955**	0.24	0.27
Ulmus pumila	1,090	1,074	26,422	66,680	49,254	79,634	106,657	0	**330,812**	1.18	0.25
Acacia constricta	909	19,771	5,686	0	0	0	0	0	**26,365**	0.09	0.22
Cupressus sempervirens	2,544	9,930	6,355	10,129	0	0	0	0	**28,958**	0.10	0.22
Koelreuteria paniculata	1,015	12,882	12,040	10,129	38,132	0	0	0	**74,198**	0.26	0.22
Olea europaea 'Swan Hill'	4,634	3,042	0	0	0	0	0	0	**7,676**	0.03	0.18
Pinus roxburghii	143	5,587	25,857	13,867	0	0	0	0	**45,455**	0.16	0.18
Ligustrum lucidum	1,166	8,767	6,355	14,349	0	0	0	0	**30,637**	0.11	0.16
Cupressus leylandii	428	0	5,844	58,145	21,863	0	0	0	**86,280**	0.31	0.15
Phoenix dactylifera	0	0	827	14,081	0	0	0	0	**14,908**	0.05	0.15
Prosopis pubescens	2,049	2,266	0	0	0	0	0	0	**4,315**	0.02	0.14
Acacia greggii	1,817	4,741	0	0	0	0	0	0	**6,559**	0.02	0.13
Melia azedarach	461	1,600	6,283	39,367	13,652	0	0	0	**61,362**	0.22	0.12
Platanus wrightii	0	0	2,681	17,215	81,638	0	0	0	**101,534**	0.36	0.12
Schinus molle	0	1,521	30,436	30,386	27,010	0	0	0	**89,353**	0.32	0.12
Tamarix chinensis	2,558	0	5,127	12,990	0	0	0	0	**20,675**	0.07	0.10
Prunus spp.	869	4,042	7,264	0	0	0	0	0	**12,175**	0.04	0.08
Malus sylvestris	201	7,522	5,127	0	0	0	0	0	**12,850**	0.05	0.07
Quercus muehlenbergii	406	2,180	2,373	0	0	0	0	0	**4,958**	0.02	0.07
Fraxinus velutina 'Glabra'	0	0	4,013	33,762	0	0	0	0	**37,776**	0.13	0.05
Prunus caroliniana	1,393	0	0	0	0	0	0	0	**1,393**	0.00	0.05
Parkinsonia microphylla	1,338	0	0	0	0	0	0	0	**1,338**	0.00	0.05
Eucalyptus camaldulensis	0	3,496	0	0	0	0	0	0	**3,496**	0.01	0.05
Quercus berberidifolia	363	2,147	0	0	0	0	0	0	**2,510**	0.01	0.04
Quecus shumardii	727	0	0	0	0	0	0	0	**727**	0.00	0.04
Acacia pendula	0	0	4,013	5,908	19,066	0	0	0	**28,988**	0.10	0.03
Eucalyptus spp.	606	0	0	0	0	0	0	0	**606**	0.00	0.03
Punica granatum	545	0	0	0	0	0	0	0	**545**	0.00	0.03
Quercus rugosa	363	1,074	0	0	0	0	0	0	**1,437**	0.01	0.03
Yucca brevifolia	0	2,147	5,686	0	0	0	0	0	**7,833**	0.03	0.03
Ailanthus altissima	327	0	0	0	0	0	0	0	**327**	0.00	0.02
Eucalyptus microtheca	0	0	0	20,257	0	0	0	0	**20,257**	0.07	0.02
Eucalyptus polyanthemos	182	0	0	10,129	0	0	0	0	**10,310**	0.04	0.02
Fraxinus uhdei	135	493	0	0	0	0	0	0	**629**	0.00	0.02
Quercus suber	182	1,074	0	0	0	0	0	0	**1,255**	0.00	0.02

Species	DBH Class (in)								Total ($)	% of Total	% of Pop.
	0-3	3-7	7-13	13-19	19-25	25-31	31-37	37+			
Acacia saligna	0	0	2,900	0	0	0	0	0	**2,900**	0.01	0.01
Arbutus unedo	106	0	0	0	0	0	0	0	**106**	0.00	0.01
Carya illinoinensis	0	0	4,013	0	0	0	0	0	**4,013**	0.01	0.01
Callistemon viminalis	144	0	0	0	0	0	0	0	**144**	0.00	0.01
Cercis canadensis	182	0	0	0	0	0	0	0	**182**	0.00	0.01
Cercis occidentalis	148	0	0	0	0	0	0	0	**148**	0.00	0.01
Grevillea robusta	0	307	0	0	0	0	0	0	**307**	0.00	0.01
Leucaena retusa	257	0	0	0	0	0	0	0	**257**	0.00	0.01
Myrtus communis	257	0	0	0	0	0	0	0	**257**	0.00	0.01
Prunus dulcis	0	1,909	0	0	0	0	0	0	**1,909**	0.01	0.01
Prunus persica	284	0	0	0	0	0	0	0	**284**	0.00	0.01
Prosopis spp.	0	0	3,383	0	0	0	0	0	**3,383**	0.01	0.01
Margin of error									**8,924**		
Citywide total	**$723,524**	**$3,968,859**	**$9,117,253**	**$8,490,577**	**$4,187,209**	**$1,254,916**	**$314,709**	**$0**	**$28,065,970**	**100%**	**100%**