

## **3.4. City-maintained trees along streets and parkways**

### **Introduction**

The City of Rocklin Public Works Department maintains trees along arterial streets and parkways throughout the City. These include plantings in street medians and along street shoulders. Well-designed and properly maintained street tree plantings not only enhance the aesthetics of City streets and the community as a whole, but can provide a variety of other benefits. Shading and evaporative cooling provided by trees are obvious benefits, but street trees can also help intercept particulate and gaseous air pollutants; moderate stormwater runoff; increase traffic safety through "traffic calming" effects that tend to reduce vehicle speed; extend the life of asphalt paving through shading; and have positive economic impacts on businesses located along streets (see Section 1 for a more detailed discussion of tree-related benefits).

### **Overview**

#### **Findings**

- In 2004, the City maintained an estimated 10,000 trees along approximately 28 miles of streets.
- The majority of surveyed City-maintained street trees were young trees that are in relatively good condition.
- About 7% of the tree planting spaces were empty, mostly due to the death of young trees.
- Street tree plantings included a moderately diverse assemblage of species. Diverse plantings may be less susceptible to severe pest or disease problems than plantings that rely heavily on only a few species. Existing City regulations emphasize uniformity for aesthetic reasons.
- Current City design guidelines require or strongly recommend the use of drought tolerant species. About one third of the surveyed street trees can be classified as drought tolerant. Some of the most common tree species in street plantings have relatively high water requirements and may not have good long-term prospects in street plantings.
- At least 15% of the City street trees were species that are small at maturity. Although these trees provide visual accents, they provide only low levels of shade and other benefits related to tree canopy.

#### **Management issues and recommendations**

- To optimally maintain the population of young and mature City street trees present in 2004, City crews would need to inspect and, as needed, prune about 2,700 street trees per year. Most (about 2,000) of these are young trees that need early training to minimize future maintenance expenses.
- Irrigation is critical for maintaining the condition of most of Rocklin's street trees. Increased use of more drought-tolerant species would reduce street tree maintenance costs.

### 3.4-City-Maintained Trees along Streets and Parkways

- Phased replanting of empty sites could be used to increase the percentage of drought tolerant species among City street trees and increase age diversity within the plantings.
- Soil problems have been a common cause of poor tree performance in street tree plantings. When dead trees are removed, the planting site should be assessed to determine whether adverse soil conditions need to be corrected before the site is replanted.
- Because soil conditions and planter arrangements can vary widely between different roadway segments, long-term management plans should be developed for specific street segments to guide tree replacement.
- By monitoring species composition of new plantings, the City can avoid overuse of the most common tree species.
- City regulations emphasizing uniformity in tree plantings should be amended to recognize the benefits associated with species and age diversity in plantings.
- If street shading and other benefits of tree canopy are a goal of street tree plantings, greater use of large-statured trees will be needed in future plantings.

## **Current status**

### **Existing Regulations and Plans**

Various City regulation and planning documents encourage tree planting along City streets. These include the Street Tree Ordinance (Rocklin Municipal Code chapter 12.08), the General Plan, development plans, and design guidelines.

The Street Tree Ordinance, first adopted in 1979 and revised slightly in 1993, calls for a program to plant and maintain trees on publicly owned property in the City of Rocklin. The ordinance states that the purpose of the tree program is to beautify the City, purify its air, and provide shade for its inhabitants. The ordinance stresses beautification as a primary goal in tree selection (Sections 12.08.010.A, 12.08.040.B.2) although shade is also noted in the latter section. The ordinance also has provisions related to City tree maintenance and protection of City trees from damage or unauthorized maintenance.

The City Manager is responsible for enforcing and implementing the street tree program, and has designated the Public Works Director to administer the requirements of the ordinance, as allowed for in the ordinance. The main instrument of the tree program specified in the ordinance is the official tree planting list. The ordinance specifies that only species on the list are to be used for all new and replacement tree plantings on City streets. The list is supposed to be updated on an ongoing basis. However, the most current version of the approved tree list that Phytosphere reviewed, which appears in the Department of Public Works Improvement Standards (section 4-26), was somewhat out of date and didn't completely reflect species currently in use.

The Improvement Standards also includes standards related to tree planting (section 12-8) which apply to City-maintained street trees. They encourage the use of drought tolerant species, provide standards related to the size of tree planting stock, specify minimum setbacks, and require tree plantings to conform with City-approved street tree master plans where applicable.

Various planning documents also specify policies and standards related to City street trees. General Plan Circulation Policy 7 requires landscaping and tree planting along major

new streets and highways, and along existing streets as appropriate. The Northwest Rocklin General Development Plan and the Northwest Rocklin Design Guidelines are typical planning documents for new development within the City. The Design Guidelines state that landscape corridors along all arterials should be designed to create a sense of unity along the streets and within the community. They require that landscaped medians be provided in major arterial streets. They also specify that a dominant species of tree is to be designated for each major roadway to “provide visual continuity and harmony”. Similar language related to uniformity in tree plantings is found in the tree ordinance. The guidelines require that maintenance in the public right-of-way be funded by a local assessment district or other acceptable funding mechanism.

The Landscaping section of the Northwest Rocklin Design Guidelines also encourages the use of plants with low water requirements. It states that drought tolerant plant materials and the use of efficient irrigation systems are strongly recommended and may be required. The design guidelines also call for the use of various landscaping techniques to improve growing conditions in areas affected by soils with low soil water holding capacity and/or limited rooting depth.

The Northwest Rocklin General Development Plan also requires that developers use drought-resistant plant species in landscaping where appropriate. It requires all street landscaping, whether publicly or privately owned, to be irrigated by a permanent drip system or low water consumption system acceptable to the City. Responsibility for street landscape maintenance is either (a) assigned to adjacent commercial, business/ professional, or industrial users or a Homeowner's Association, or (b) funded by placing the landscape areas into the City Landscape and Lighting District, a Community Facilities District, or similar financing district.

The Southeast Rocklin Circulation Element, which pertains to the portion of the City southeast of I-80, is intended to minimize the impact of road construction on existing riparian corridors and oak woodlands. Policies in this element seek to minimize impacts to trees by avoiding impacts in the design phase and mitigating for necessary impacts through tree protection, replanting, and habitat restoration. Policy 37 requires that oak trees (6 inches or more in diameter) removed as a result of road construction be replaced in kind at a 2:1 (replaced:removed) ratio or greater in areas adjacent to the roadway.

#### **Current management practices**

City of Rocklin Public Works staff provided information about their street tree program in the spring of 2004. This information on existing management practices is summarized below. A brief account of past and current tree maintenance practices prepared by Public Works Staff is also included in Appendix 7.2. To a large degree, the current status of street tree resources largely reflects past maintenance practices, dating back 10 or more years. Likewise, the impact of current management practices will be evident in the future, as tree growth and health are shaped by current maintenance practices.

The City of Rocklin Public Works Department currently (2004) maintains trees along about 28 miles of arterial streets and parkways throughout the City. These include plantings in street medians and along street shoulders. Currently Public Works prunes about 300 trees a year, and removes about 12 trees. About 70% of this tree care work follows an inspection pruning cycle. The remaining 30% is performed in response to problems and complaints.

### 3.4-City-Maintained Trees along Streets and Parkways

Funds to pay for street tree work are derived from assessment districts that pay for overall upkeep of landscaped areas along streets, the general fund, and gas tax revenues. Public Works does not have a separate budget category for tree work along streets. In the past fiscal year, expenditures for street tree replacement were about \$25,000. About 10% of Public Works' tree care dollars are spent on work done by contractors. Public Works staff indicated that the current budget for tree planting and maintenance was not adequate to meet current needs. In general, funding for street tree work has increased in newly built areas and decreased in older parts of town. This situation does not necessarily reflect maintenance needs, since older plantings commonly require more expensive tree care work than young plantings.

Current street tree care requires about one full-time equivalent (FTE) of staff time per year. Despite the increasing number of trees managed by Public Works in recent years, staffing for the tree program has not increased over the past five years. As of March 2004, Public Works did not have any staff with International Society of Arboriculture (ISA) arborist or tree worker certification. However, the department has been upgrading staff training and working to develop a trained Urban Forest Tree Crew unit.

Public Works follows ISA / ANSI pruning standards in its tree work. However, the need to obtain adequate street clearances (14 feet) sometimes requires levels of pruning that may exceed ISA standards. Public Works also requires contractors that perform tree care for the City to follow ISA pruning standards. Private contractors have been used for tree planting, pruning small and large trees, emergency work, large tree removal, pest control, and for providing specialized equipment. Public Works reported that both arborist services and tree maintenance provided by contractors have increased over the previous five years. Public Works staff reports that they have been generally satisfied with the work performed by most private contractors.

Prior to 1994, street trees that died were not replaced. Between 1995 and 1998, some efforts were initiated to replace dead street trees, but starting in 1999 a tree replacement program was instituted for City trees in street plantings. Through this program, trees are replaced as a result of automobile accidents, and storm or wind damage. Trees lost prior to the start of the program are now being replaced. A list of needed replacement trees is compiled over the year and trees are planted in the fall, which is the optimal time for tree planting in the Rocklin area. Trees damaged in automobile accidents represent an exception to this procedure. These trees are replaced within days of their loss and replanting is done by contractors. The cost of replacing trees damaged or destroyed by auto accidents is recovered by insurance payments from the responsible parties.

Public Works has made efforts to improve tree performance in street tree plantings. These include replacement of turf with other materials to reduce damage from mowing equipment and competition between trees and turf, and changes in tree species selection to improve diversity and tree-site compatibility. Some problems associated with soil conditions are an ongoing source of problems. Tree roots cause damage to sidewalks and median curbs throughout the City. Public Works typically responds by removing the offending root and installing root barriers. Poor soil conditions and high water tables in some areas also cause waterlogging of planting sites in some areas, causing trees to decline or perform poorly. Shallow soils in some areas can also make trees prone to drought stress, especially through the summer months.

### 3.4-City-Maintained Trees along Streets and Parkways

Problems such as excessive surface rooting and poor drainage are often associated with excessive soil compaction developed at the time of construction. Although it may be possible to at least partially correct various adverse soil conditions during the original construction of streets (e.g., by decompacting planting beds through tillage), options are much more limited in established beds due to the presence of existing vegetation, irrigation pipes, wiring, and other infrastructure.

#### Field assessment of City-maintained street trees

In order to manage City-maintained street trees effectively, the City needs information on the number and kinds of trees present. Due to a lack of inventory or sample survey data, this critical information on City-maintained street trees was lacking. In October 2003, Phytosphere surveyed a random sample of street segments with City-maintained trees and collected data on tree density (trees per street mile). This tree density data was used to estimate the total number of trees in City-maintained street plantings. Phytosphere also assessed tree age class, condition, and species, and noted empty planting spaces. Details of the survey methods used are presented in Section 7.1.4.

#### Characteristics of surveyed areas

The street segments included in our survey of Rocklin's City-maintained street landscaping are listed in Table 3.4-1 and illustrated in Figure 3.4-1.

**Table 3.4-1. Street segments included in the survey of City-maintained street trees. Also listed are the locations of tree plantings within the segments (medians and/or shoulders), and the number of empty planting spaces observed in each segment. Counts of empty spaces do not include dead trees that were still standing in place.**

Street	Segment number	Nearby cross streets	Median	Shoulders	Empty spaces
Blue Oaks Blvd.	15	Taft Dr./Sonora Pass Way/Tanager Way	yes	one side	2
Crest Dr.	3	Tahoe Vista Dr./Newland Heights Dr.	no	both	2
Pacific Ave.	7	Oak St./E. Midas Ave.	yes	both	2
Park Dr.	4	Coldwater Pl./Lake Tahoe Ct.	no	both	4
Park Dr.	11	Farrier Rd./Twin Oaks Park	yes	both	*
Rocklin Rd.	8	El Don Dr./Havenhurst Cir.	yes	no	0
S. Whitney Blvd.	13	Lincoln Way/Springview Dr.	yes	no	**
Scarborough Way	9	Helmsdale Way/Camborne Way	yes	both	7
Stanford Ranch Rd.	1	Stoney Rd./Cobblestone Dr.	yes	both	1
Sunset Blvd.	5	Atherton Rd./SR65	yes	both (extra wide)	0
Sunset Blvd.	10	S. Whitney Blvd./Springview Dr./3rd St	yes	no	1
W. Stanford Ranch Rd.	6	Sunset Blvd./Sioux St.	yes	no	2
West Oaks Blvd	2	Wendall Ct./Talon Dr.	yes	both	6
Whitney Blvd.	12	Midas Ave./Argonaut Ave./Topaz Ave.	yes	no	4
Wyckford Blvd.	14	Park Dr./Concord Rd./ Steward St.	yes	both	3

\* Although 10 empty planting spaces were noted as missing in the survey, some of the empty planting spaces in this segment were from trees that were removed to improve lines of sight along the roadway, so the actual number of empty spaces is unknown. \*\* All but one of the trees along this section are volunteers growing among the planted oleander hedge, so the empty tree space criterion used does not apply. The section has the potential to support trees planted at a standard density for most of its length (e.g., about 20 more trees at a spacing of 30 feet).

### 3.4-City-Maintained Trees along Streets and Parkways



**Figure 3.4-1. Locations of street segments (white lines) included in the survey of City-maintained street trees (background: 2003 aerial photo).**

Only two of the surveyed segments did not include planting beds in the medians (Figure 3.4-2). Five did not include shoulder plantings either because the areas were undeveloped (e.g., W. Stanford Ranch Rd.) or because the street shoulders were lined by residential front yards (e.g., Whitney Blvd., Figure 3.4-3) or commercial properties (e.g., Sunset near 3<sup>rd</sup>, Figure 3.4-4).

### 3.4-City-Maintained Trees along Streets and Parkways



**Figure 3.4-2. Narrow City-maintained shoulder plantings along Park Drive near Lake Tahoe Ct. No center median plantings are present in this area.**



**Figure 3.4-3. City-maintained center median planting along Whitney Blvd. Shoulder areas are not City-maintained and include residential front yards and plantings along the golf course.**

### 3.4-City-Maintained Trees along Streets and Parkways



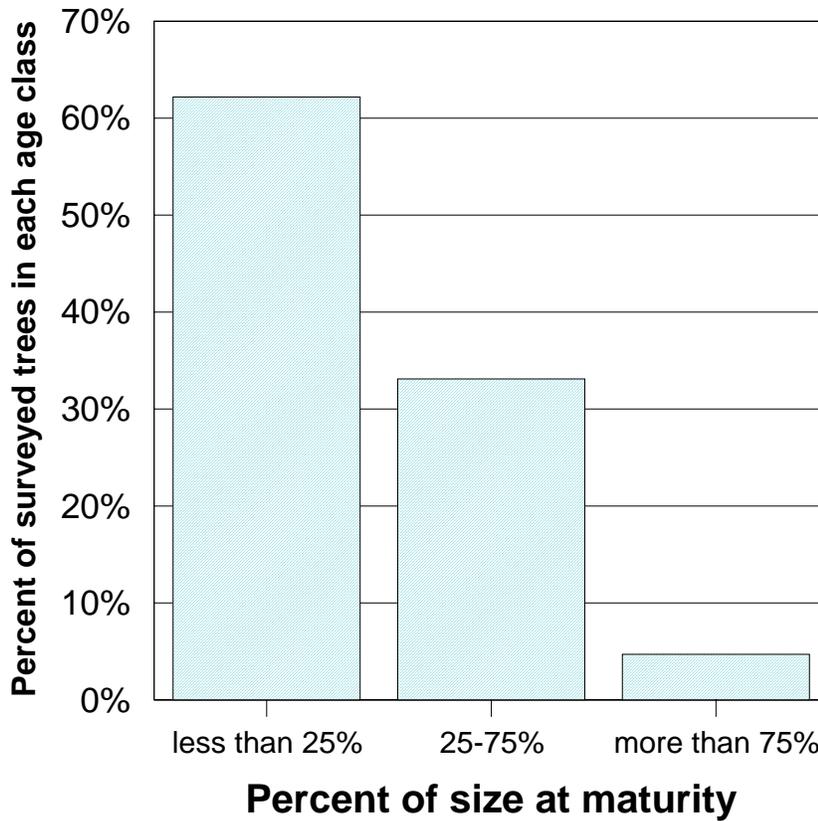
**Figure 3.4-4. Trees in center median on Sunset Blvd. near 3<sup>rd</sup> Street include a double row of purple leaf plums. Trees are situated to accommodate future widening of the street which will remove part of the median. Shoulders have no City-maintained trees.**



**Figure 3.4-5. Wide planting beds on both shoulders and a center median bed (which is not continuous over the entire surveyed section) on Sunset Blvd. near Atherton. The extra wide shoulder areas are designed to accommodate future lane expansion. Coast redwoods on the left are on private property just beyond the City-maintained shoulder plantings. Most trees in this area are London plane and coast redwoods.**

**Tree age class**

Phytosphere compared current tree size to the typical size of a given tree species at maturity to categorize trees into functional age classes. Most of the surveyed street sections had relatively young tree plantings. Trees had just been installed on the Rocklin Road segment, and many other areas included recently developed or recently renovated planting beds. Consequently, the majority of all trees were rated in the youngest age class, less than 25% of mature size (Figure 3.4-6).



**Figure 3.4-6. Most of the surveyed City-maintained street trees are in the smallest and youngest age class, less than 25% of their mature size.**

**Tree density**

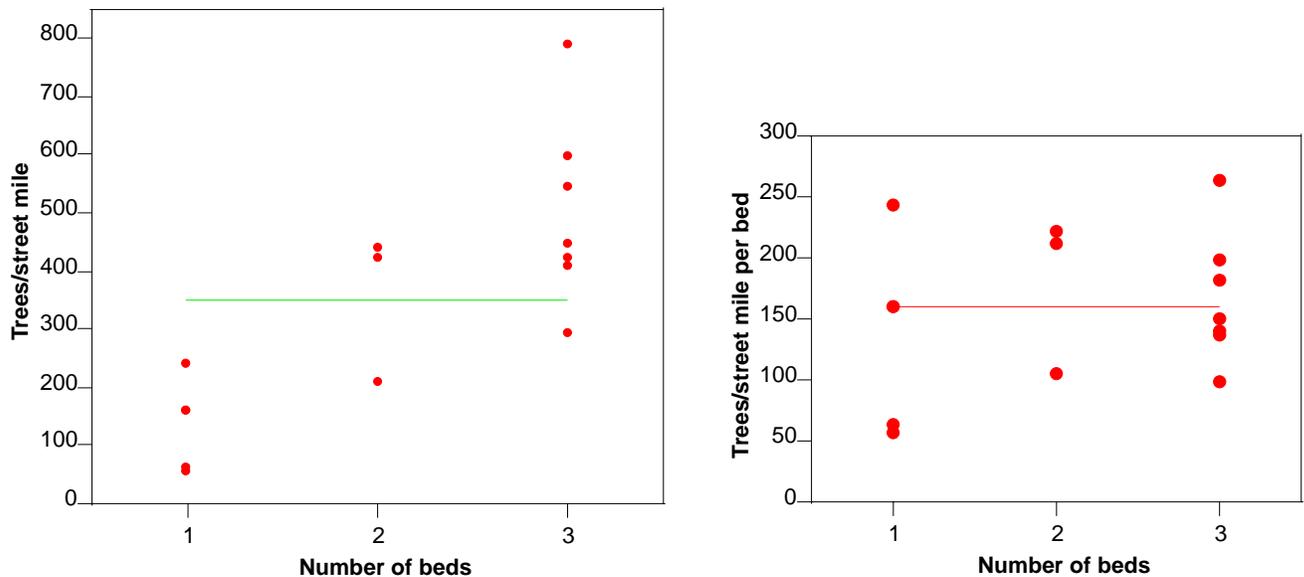
For the 15 surveyed segments, the overall density of trees per street mile was 353. The density per street mile ranged from 58 (W. Stanford Ranch Rd.) to 792 (Sunset at Atherton), but the density for most segments was between about 160 and 450 trees per street mile. By way of comparison, among over 200 California cities that provided street tree data in the 1992 California Urban Forest Survey (Bernhardt and Swiecki 1993), the average street tree density was 103.5 trees per street mile.

Much of the variation in the number of trees per street mile is associated with the number of landscaped beds per street segment, which ranges from one (e.g., center median only) to three (median plus both shoulders) (Figure 3.4-7). If the number of planting beds is taken into account, the average number of trees per street mile per planting bed is 160, with a

range of 58 to 264 (Figure 3.4-7). This corresponds to an average of one tree for every 40 feet of roadway per landscaped bed.

Many of the species in these City-maintained street tree plantings (see below) do not have a very wide canopy spread at maturity. Assuming an overall average canopy spread of 25 to 30 feet at maturity for each tree, an average of one tree per 40 feet of roadway will generally not provide a continuous tree canopy if all trees reach mature size.

Actual planting density within beds is typically somewhat higher than one tree per 40 feet because many beds are interrupted by areas such as intersections that do not contain trees. The numbers presented above are based on the total length of each sampled street segment, including intersections and other interruptions in the planting beds. Hence, trees are planted densely enough within many street landscaping beds to provide continuous tree canopy within at least portions of the bed, even though the street as a whole will not have a continuous tree canopy.



**Figure 3.4-7. The relationship between tree density and the number of planting beds is illustrated in these graphs. The left graph shows that the number of trees per mile of street increases with the number of planting beds along the street (i.e., center median and/or one or both shoulders). In the graph at right, the tree density of the surveyed street segments have been put on an equivalent basis by dividing by the number of planting beds present. Horizontal lines represent the overall average for all sampled streets in each graph. Variation in tree density between different beds is due to differing planting designs, mature tree size, and site conditions.**

From the overall density of trees per street mile (353) in sampled streets and the number of miles of streets with City-maintained trees (approximately 27.7 miles in 2004), Phytosphere estimated that the overall number of City-maintained street trees is approximately 9,800. There is a fair amount of uncertainty in this estimate. Statistically, there is a 95% chance that the actual number of City-maintained street trees is between 6,600 and 12,960. A more precise estimate could be obtained by sampling more street segments and/or by using the per planting bed estimate in conjunction with the total length of City-maintained planting beds along streets. The estimate does not include approximately 1.8 miles of street landscaping (on Pacific St., Sunset Blvd., and Granite Drive) which were not

yet under City maintenance at the time of our survey. If tree densities in these areas are similar to the average of sampled areas, these areas may include approximately 640 additional trees.

Most of the surveyed street segments (12 of 15) had at least one empty tree planting space (Table 3.4-1). Overall, 5% of the planting spaces in the surveyed street segments were empty in October 2003. City-wide, this would represent about 820 trees, based on our estimate of the City street tree population. Most of the empty planting sites were places where trees had died during the establishment period and had not been replaced. Larger trees were removed in only a few of the sites. A few of the empty sites are spots where trees have been intentionally removed to improve lines of site (some of the trees in segment 11). As noted earlier, Public Works initiated a formal program to replace missing street trees in 1999.

In addition to street trees, City crews also maintain vegetation that includes trees at the Rocklin Museum Parking Lot, Fire Station # 2, and the Stanford Ranch Road Park and Ride lot. Trees in these areas are not included in our overall tree count estimates, but contribute to Public Work's overall tree care work load.

#### **Species composition**

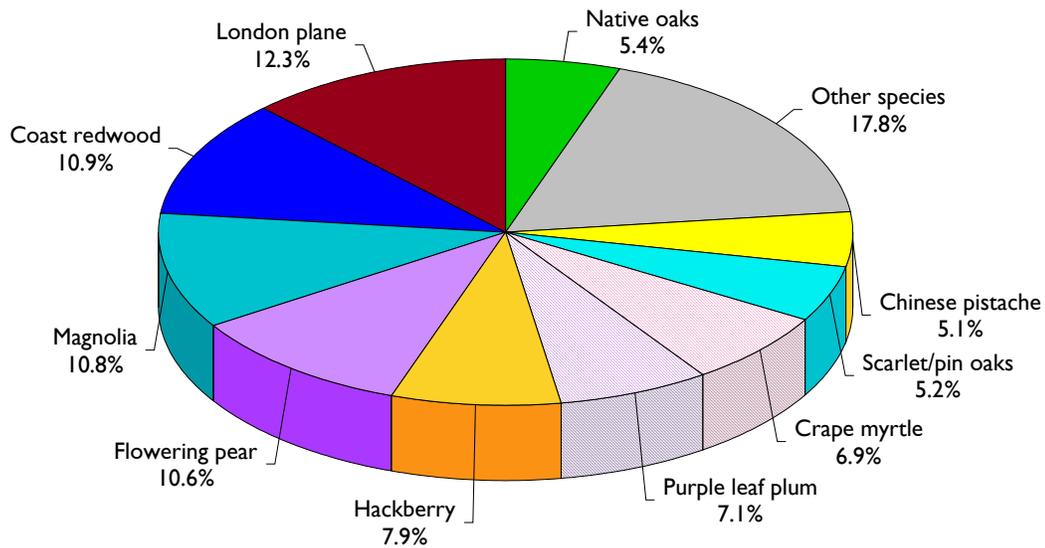
At least 26 species of trees were present within the sampled street segments. However, many of the observed species were represented by only a few individuals. The 12 least common species made up only 8.5% of all surveyed street trees. By comparison, the 5 most common species make up more than 50% of the sample in the survey. This is not surprising given the emphasis on aesthetics and planting uniformity called for in the Street Tree Ordinance and City planning documents. Figure 3.4-8 shows all species that made up at least 5% of the sample.

In general, a high level of diversity is desirable to reduce the chance that a major problem that develops in one species will impact a high percentage of the total tree population. A commonly-used guideline is that a single cultivated species should not make up more than 10% of the urban street tree population. The four most common street tree species in the survey each constitute about 10% of the total street tree population, which is consistent with the above guideline.

About one third of the trees in the sample (32%) could be classified as being drought tolerant, i.e., able to perform reasonably well with low or very low levels of irrigation. However, about 20% of the trees in the sample were coast redwoods and magnolia, both of which have relatively high water requirements. In hot, dry inland areas, trees with high water requirements typically develop drought stress when planted in harsh sites. Street tree planting beds are typically harsh environments for tree growth due to both restricted rooting area and additional summer heat radiated from pavement. Although trees such as coast redwood may perform well over the short term along streets, older coast redwood plantings in other inland sites in northern California have not fared well, eventually developing significant top dieback. The long-term prospects for coast redwood in Rocklin street plantings are doubtful, particularly if drought conditions were to occur that would require reduced irrigation.

About 21% of the trees in the sample (including crape myrtle, purple leaf plum, and crabapple) are small-statured trees. These trees provide aesthetic benefits and are relatively inexpensive to maintain, but they are too small to provide significant shading, and provide only minimal benefits in categories such as air quality improvement and stormwater retention.

### 3.4-City-Maintained Trees along Streets and Parkways



**Figure 3.4-8. The most common tree species in sampled City-maintained street tree plantings. All species comprising at least 5% of the sample are shown. Three locally native oak species in the sample (blue, interior live, and valley oak) are grouped. Small-statured trees are indicated by stripes; solid colors represent medium to large-statured trees. The ‘Other species’ group includes small to large-statured trees.**

#### **Tree condition**

Dead and declining trees were found in 7 of the 15 surveyed street sections, but were quite uncommon overall. Only 1.7% of the trees in the sample were in decline and 0.24% were dead. Combined with empty planting spaces as noted above, about 7% of the street tree population is either in decline or has died since installation and not been replaced. Poor condition of the original nursery stock, poor soil conditions at the site, and/or inadequate irrigation appeared to be the most common causes for the decline and death of street trees. In cases where poor soil conditions are the main underlying cause of tree death (such as on shallow granitic or “lava cap” soils), replanting of the site may not be warranted unless a major renovation of the planting bed is undertaken to change soil conditions.

Declining trees were present at nearly the same frequency among all three tree age classes. Among the most common species, shown in Figure 3.4-8, declining or dead trees were found among magnolia, flowering pear, scarlet/pin oak, purple leaf plum, and Chinese pistache.

#### **Management issues and recommendations**

The sample street tree survey provides an estimate of the overall number of trees that are maintained along streets by Rocklin Public Works. In turn, this can be used to estimate the amount of time required to inspect and prune trees.

In order to develop good branch structure that will reduce later maintenance needs, most young trees should be inspected, and pruned as needed, on a two to three year cycle until the

### 3.4-City-Maintained Trees along Streets and Parkways

permanent branch structure is developed. This is most important for hardwood trees (i.e., trees other than conifers) that will be medium to large-statured at maturity. Early training of conifers that have a typical excurrent growth pattern (like a Christmas tree) is much less critical and mainly consists of eventually removing low branches to develop clearance. About 62% of the sample, or an estimated 6,000 trees City-wide, fall in the youngest age class (<25% of mature size). If conifers and small-statured trees (e.g., crape myrtles) are deducted from this group, an estimated 4,600 young street trees are likely to need inspection and pruning to establish good tree form. To maintain these trees using a three year cycle, about 1,500 trees per year would need to be inspected and pruned as needed. For the remaining 5,400 street trees, a longer inspection/pruning cycle, on the order of 5 to 7 years, may be appropriate. A mean interval of six years would require that an additional 900 trees per year be inspected and pruned as needed.

With a more extensive sample survey or a complete tree inventory, the maintenance needs for City street trees could be estimated and scheduled more precisely. The number of City-maintained trees is expected to increase as the City assumes responsibility for new sections of street landscaping. Also, as young trees begin to mature, they can be inspected and pruned less frequently. Hence, the number of trees to be inspected and pruned per year, and the type of pruning needed (young vs. mature tree) will continue to change over time for some years to come. A city street tree inventory, even a partial one based on sample data, would help the City track and forecast its street tree maintenance over time. As noted in Section 3.3, software for tree inventory and tree work scheduling is available from various sources.

Irrigation is also a critical maintenance issue. Many of the most common street tree species, comprising over half of the trees in the sample (Figure 3.4-8), have at least moderate irrigation requirements. Coast redwoods, which make up more than 10% of the sample, have a high irrigation requirement. As noted above, street tree plantings tend to be especially stressful because soil conditions are typically poor (high compaction, restricted soil volume) and summer water demand is high due to heat radiated off paved surfaces. In these sites, trees with moderate to high moisture requirements can easily become critically stressed if irrigation is inadequate. Improperly adjusted timers or malfunctioning equipment can result in water deficits that can severely damage established trees and can kill young trees.

Maintenance needs in street tree plantings could be reduced by phasing out high water-use species in favor more drought tolerant species. In many sites, drought tolerant tree species, including locally native oaks, may be able to grow with little or no irrigation. For example, in relatively wide beds that have adequate amounts of soil that is suitable for root growth, species such as blue oak should be capable of surviving without irrigation once established. Because blue oak would grow relatively slowly in these sites, its pruning requirements would also be low. In many sites, it may be possible to establish locally native oaks from seed among existing plantings. Eventually, such oaks could replace shorter-lived, higher maintenance species that were originally present in the plantings. This process has already started naturally in some planting beds, such as the median on South Whitney Blvd., where native oaks have become established from acorns planted by scrub jays.

As noted above, about 7% of the available planting spaces in the beds were unoccupied or contained dead or declining trees. Before a missing site is scheduled for replanting with the same species that had died, Phytosphere recommends that an assessment be made to determine the likely cause(s) of tree death or decline. Potential causes of tree death may

include adverse soil conditions (e.g., compaction, shallow soil depth), irrigation system problems, poor match between species and site conditions, poor condition of the original planting stock (e.g., circling roots), and disease or insect pest problems. This assessment should be made at the time a dead or declining tree is removed, when many of these problems can be readily observed. Based on these findings and a functional evaluation of the site, a determination can then be made as to:

- whether the site should be replanted at all;
- whether remedial site preparation is needed before replanting; and
- which species would be most likely to perform well at the site.

This type of replacement strategy will help the City optimize its use of scarce tree planting funds. However, to be effective, long-term management plans need to be developed for individual street segments so that individual tree replacements will contribute toward attaining the plan's objectives.

Although the current plantings are moderately diverse, relatively few species still make up a large percentage of the street tree population. Many of the most common species in use are clonally propagated varietal selections. All individuals of a horticultural variety (e.g., Capital flowering pear, *Pyrus calleryana* var. 'Capital') are genetically identical. In contrast, a population of trees of a given species raised from seed can have high amounts of genetic diversity. Such diversity is important in reducing the impact of pest or disease epidemics. In both new tree plantings and replanting of existing landscape beds, it will be important to avoid the overuse of already common tree species, especially clonal varieties. In addition to maintaining genetic diversity in street tree plantings citywide, it is also important to consider the level of diversity as part of the street segment management plan. Genetic diversity can be increased not only by using a wider mix of species, but by using species propagated from seed (e.g., local native oak species) or using multiple clonal varieties rather than a single variety.

Age diversity within plantings is also an important factor that affects the long-term sustainability of the street tree population (Maco and McPherson 2003). Especially when genetically uniform clonal varieties are used, trees of a given species planted at a site at one time will also tend to reach the end of their useful life at the same time. In plantings that have a diversity of species and tree ages represented, only a small percentage of the trees will need to be replaced in any given year. Currently, Rocklin's street tree plantings have low levels of age diversity, i.e., most street trees citywide fall in a relatively narrow age range. Phased replacement of dead trees in the existing plantings following the replacement protocol outlined above will help produce a more stable mix of species and tree ages. This will also allow the City to gradually replace short lived species used in the original plantings with longer-lived, better adapted species.

A moderate percentage of the tree species in the current plantings will be small-statured at maturity. Small tree size is necessary and desirable in tight planting situations, including plantings under utility lines. However, a number of relatively large beds with dense plantings of small-statured trees such as purple leaf plum could alternatively accommodate a smaller number of large-statured trees. One consequence of the current planting pattern is that little or no tree canopy is actually directly over pavement, so street surfaces will not receive substantial amounts of shade during the hottest periods. Many of the benefits that street trees provide are directly related to canopy size, and researchers have shown that the benefit-to-cost ratio generally increases with tree size (McPherson 2003). Overuse of small-statured trees greatly reduces many of the benefits that are associated with street tree plantings.

### 3.4-City-Maintained Trees along Streets and Parkways

In setting goals for the urban forest, City policymakers may want to consider increasing the level of canopy cover over street pavement. For example, the Street Tree Policies for the City of Los Angeles include the following objective:

“Achieve an optimum degree of canopy cover in order to shade City streets and thereby help mitigate the urban heat island effect, and maximize the benefits from the urban forest ecosystem.” (<http://www.cityofla.org/BOSS/streettree/StreetTreePolicies.htm>)

Various other cities have similar street tree policies. Such a policy would represent a shift from current policy, which emphasizes the use of street trees for aesthetic benefits rather than as providers of diverse benefits related to canopy cover.

## References

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