1. Introduction

Trees provide a variety of benefits, particularly in the urban environment. Trees in cities are widely appreciated for their aesthetic qualities. Trees play a large role in the identity of many cities. For example, a search of the internet shows that many cities throughout the world embrace the term "City of Trees" as part of their community identity.

Trees make cities more livable in a variety of ways. Some of these are difficult to quantify in economic terms. For example, trees and shrubs can help muffle urban noise, and trees provide important foraging and nesting opportunities for birds and other wildlife. However, it is possible to assign a dollar value to some of the benefits that trees provide, which emphasizes the importance of the urban forest as a key element of urban infrastructure. Researchers at various institutions have been working to quantify some of the benefits provided by the urban forest. In particular, scientists at the Center for Urban Forest Research (http://cufr.ucdavis.edu/) at the University of California, Davis, have been studying the economic benefits of trees in California communities since 1992. Their results are available online as both technical reports and short summary handouts.

Trees help save energy

In hot climates, one of the principal economic benefits provided by trees is due to shade.

☙ Trees in residential yards that shade western and eastern facing windows, roofs, and walls can reduce energy needed for cooling by as much as 34% (Simpson and McPherson 1996).

☙ On hot summer days, temperatures within urbanized areas can be up to 10°F hotter than the surrounding countryside, a phenomenon known as the urban heat island effect (http://www.epa.gov/heatisland/). Buildings and pavement made of dark materials absorb the sun's rays, leading to an increase in the temperature of the surfaces and the air around them. Trees and other vegetation reduce summer temperatures through direct shading of surfaces and through the process of evapotranspiration. Evapotranspiration refers to the way that water is evaporated from within plant leaves, exiting through tiny pores in the leaf. As the water evaporates, it cools the leaf and the air around it in much the same way that swamp coolers function. By combating the urban heat island effect, trees reduce the overall summer temperature within urban areas, helping to reduce energy use.

☙ Trees serve as windbreaks, which helps save energy by reducing the amount of outside air that infiltrates into heated or cooled building interiors (Heisler 1986).

Trees improve air quality

☙ Trees improve ambient air quality by removing gaseous air pollutants and particulates from the air (Scott et al, 1998).

☙ Although the majority of human-caused smog precursors come from moving vehicles, parked cars also emit volatile hydrocarbons and nitrogen oxides into the atmosphere that react to form smog. Cars parked in shade are much cooler and release fewer volatile hydrocarbons and nitrogen oxides into the atmosphere (Scott et al, 1999).

☙ As trees reduce the urban heat island effect, they also reduce the formation of photochemical smog because the chemical reactions that form smog are favored by higher temperatures (http://eetd.lbl.gov/HeatIsland/AirQuality/).

Trees provide other important urban services

🐦 Tree canopies intercept rainfall, moderating stormwater runoff and reducing the amount of pollutants that wash off buildings and paved surfaces into creeks and storm drains (Xiao et al, 1998, Xiao and McPherson 2003, Geiger 2003).

🐦 Tree shade over pavement slows down pavement deterioration (McPherson et al 1999).

🐦Trees planted along roadways can have a "traffic calming" effect which reduces driving speeds by visually narrowing the road (Otak, Inc. 2002)

🐦 Tree roots help to hold soil in place, and tree canopies shield soil from the impact of rain drops, resulting in decreased soil erosion during storms, which improves stream water quality and reduces silt deposits in reservoirs and flood control basins.

Trees provide direct economic benefits

🐦 A variety of studies show that trees increase residential property values. People pay more for homes with attractive trees, that are in neighborhoods with attractive trees, or that are near open space areas with trees. (Anderson and Cordell 1988, Wolf 1998b).

🐦 A study by researchers in the State of Washington found that consumers perceive business districts with trees to be higher quality than those without trees. Consumers were willing to pay up to 10% more for goods bought in tree-lined business districts (Wolf 2003a,b).

Social benefits related to trees

A growing body of research has shown that the presence of trees in neighborhoods and views of trees and nature contribute to both physical and mental health of urban residents.

🐦 Trees are associated with lower crime rates, and improved mental health, stronger ties between neighbors, and greater feelings of safety and well-being of City residents (Kuo 2003).

🐦 Researchers have shown that office workers who can see nature from their desks have 23% less time off sick and report greater job satisfaction than those who can not see any nature (Wolf 1998).

🐦 Hospital patients with views of trees have been shown to recover significantly faster than those who can not see any natural features (Ulrich 1985).

Benefits vs. Costs

Urban trees clearly provide a wide variety of benefits, although it is only possible to calculate an economic value for some of these. There are also obvious costs associated with planting, maintaining, and removing trees in cities. In addition, indirect costs associated with trees include the costs of clearing away fallen leaves, repairing damage to nearby structures that may be damaged by tree roots in certain planting situations (e.g., large trees planted too close to curbs and sidewalks), and the administrative costs associated with maintaining a community urban forest program. Do the economic benefits of urban trees exceed their cost?

The answer, provided by a number of studies of communities in California and elsewhere, is a definite "yes". Studies by Dr. Greg McPherson and colleagues at the Center for Urban Forest Research have consistently shown that the economically quantifiable benefits of urban trees are several times greater than their associated costs. Furthermore, their studies show that the benefit-to-cost ratio is higher for large trees than small trees (McPherson 2003). An urban forest composed primarily of trees that are small-statured at maturity provides a much lower total

economic benefit to the community and has a lower benefit-to-cost ratio than an urban forest with a preponderance of large-canopied trees (Geiger et al 2004).

Securing tree-related benefits

Many different City planning and management actions, especially those that occur during development, have a large impact on the character and condition of the urban forest. Rocklin has expanded rapidly over the past decade and is scheduled to complete its ultimate residential buildout by about 2015. Urban forest planning and management actions taken over the past decade, as well as those made in the next decade, will shape the future of Rocklin's urban forest for the next half century or more. To ensure the development of a thriving urban forest that will benefit the community, the City needs to develop a long term plan that accounts for the needs of trees in the urban environment. Both tree growth and tree decline are typically slow processes, so management actions related to these processes need to be initiated far in advance of the desired outcomes. This urban forest plan provides an overall strategy that will help the City maximize the benefits the urban forest will provide in the years to come.

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Xiao, Q.; McPherson; E.G. 2003. Rainfall interception by Santa Monica's municipal urban forest. Urban Ecosystems 6:291-302.

General sources of information on tree-related benefits

Center for Urban Forest Research, Pacific Southwest Research Station, USDA Forest Service website - http://wcufre.ucdavis.edu/default.asp

Center for Urban Horticulture, College of Forest Resources, University of Washington website - http://www.cfr.washington.edu/research.envmind/

Human-Environment Research Laboratory; University of Illinois at Urbana Champaign website - http://www.herl.uiuc.edu/

2. Recommendations for the management of Rocklin's urban and natural tree forest

This section summarizes some of the important issues and trends that are likely to affect Rocklin's urban and natural tree forest over the next 25 to 50 years and beyond. Based on these issues, local concerns and priorities, and general urban forest management principles, Phytosphere developed a list of goals that could be used to help guide the overall management of Rocklin's urban and natural tree forest. The objectives associated with these goals and recommendations for attaining these objectives constitute an overall framework for the sustainable management of Rocklin's tree resources.

These issues and related goals have been organized into three general topic areas. **Tree canopy cover** includes issues that are related to the overall amount of tree canopy in Rocklin and its distribution within the City. **Tree and forest health** addresses the long-term health and sustainability of both individual trees and the forest as a whole. **Management of the urban forest** addresses issues that are specific to the care and maintenance of the urban forest by both the public and private sectors. These main topic areas, as well as the goals and objectives listed under them are highly interrelated. Hence, objectives listed under one goal may in fact support several other goals as well.

This section includes cross references to supporting data and discussions found in other portions of this document.

2.1. Tree canopy cover

Issues and trends

- Mean summer temperatures will tend to rise due to the urban heat island effect (localized heating of urban areas associated with pavement and other heat absorbing surfaces) and overall global warming trends. Increased tree canopy cover can help moderate these impacts.
- Regional air quality will continue to be an issue of concern. The Sacramento air basin in the vicinity of Sacramento has frequently exceeded national ambient air quality standards for ozone and, to a lesser degree, airborne particulates matter. Tree canopy intercepts and reduces both ozone and particulate pollutants.
- Tree canopy cover in Rocklin has increased by 63% over the past 50 years, from about 11% in 1952 to 18% in 2003, as a result of both new tree planting and growth of existing native trees over the past 50 years (Section 3.1).
- The Sacramento Regional Urban Forest Compact (also known as the GreenPrint) establishes a goal of doubling the region's tree canopy coverage to 35% over the next 40 years.
- Many of Rocklin's existing trees are young, and with proper care will continue to grow in size, increasing overall canopy cover (Sections 3.3, 3.4, 3.5, 3.6).
- Most commercial parking lots never obtain even moderate levels of tree shading. Most parking lots achieve only low levels of tree shade within about 10 years and then begin to lose canopy as the result of both poor growth and trees loss (Section 3.6).

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- Due to tree placement and species selection, most existing residential tree plantings in front yards on private property are unlikely to provide significant shading of streets when trees mature (section 3.5).
- Native oak woodlands on Rocklin public lands are generally in fair to good condition, but low levels of natural regeneration in some areas may affect long-term sustainability of some stands (Section 3.1).
- Conserved oaks provide significant amount of tree canopy in various developed areas. However, many of these trees have sustained high levels of root damage due to both construction-related activities and subsequent alteration of the root zone and are likely to decline and be removed over the next few decades (Sections 3.1, 3.5, 3.6).

Goal 1. Establish and maintain target levels of tree canopy throughout the City.

Objective 1.1. Establish target levels of tree canopy cover citywide and for specific land use categories.

Actions

Adopt an appropriate goal and timetable for increasing overall canopy cover within the City of Rocklin.

Establish canopy cover goals for open space lands, residential areas, commercial parking lots, public facilities (including parks and schools), city-maintained parkways, and other major land use categories that will contribute to attainment of the overall canopy cover goal.

Objective 1.2. Maximize levels of successful tree establishment in new construction areas.

Actions

Continue and expand policies and programs that require or encourage tree planting in new developments.

Update existing planting standards to improve tree establishment and performance. Revisions should address improving planting site preparation (including modification of the planting hole standard), staking, tree species selection, and nursery stock quality.

Increase levels of parking lot shading by adopting and implementing standards that improve design, site preparation, and short-and long-term maintenance practices.

Objective 1.3. Maintain or increase tree canopy cover levels in existing developed areas.

Actions

Continue efforts to replant trees in publicly-maintained streetscapes and developed parks as needed to maintain appropriate levels of tree canopy.

Promote appropriate tree planting on privately-owned properties by Rocklin businesses and residents.

Objective 1.4. Increase native tree cover in City-owned natural woodlands.

Actions

Promote natural regeneration in heavily-used City-owned oak woodlands by maintaining adequate levels of organic matter on the soil surface beneath oak canopy.

Promote natural regeneration in City-owned oak woodlands by selectively protecting existing native seedlings and saplings in appropriate locations from mowing, herbicide application, or other potentially damaging maintenance practices.

Increase tree cover in historically-forested open space lands by planting with locally native tree species where appropriate. Continue and expand recent efforts by Public Works and the Parks Division to propagate and plant locally native trees in open space areas in collaboration with community volunteers.

Continue to monitor establishment, survival, and growth of restoration plantings to help refine and optimize planting methods and identify potentially limiting factors.

Goal 2. Promote conservation of existing tree resources.

Objective 2.1. Increase the level of protection provided to oaks before and during construction.

Actions

Continue enforcement of Rocklin's Oak Tree Ordinance.

Continue City policies that attempt to maximize conservation of tree cover when developing in areas that contain existing tree resources. Use site planning to protect groups of trees and minimize the amount of disturbance to the roots of existing trees by expanding the protected area for root growth.

Continue to implement tree protection measures and monitoring of trees designated to remain during development activities.

Review and update Rocklin's oak tree protection guidelines as needed to reduce tree damage during development and improve long term survival of retained trees.

Objective 2.2. Improve the management of retained oaks.

Actions

Promote good tree care practices by private tree owners by continuing to provide recommendations on oak tree care to interested citizens.

Continue and expand tree care training / education opportunities for City staff involved in oak tree maintenance and landscape planning.

Goal 3. Choose and locate new trees to maximize tree-related benefits

Objective 3.1. Match species to sites to the greatest degree possible.

Actions

Provide guidelines on tree selection and placement to residents to promote planting the right tree in the right place and avoid tree/site combinations that will result in shortened tree life or excessive maintenance costs (e.g., redwoods on thin soils, big trees planted in small places, tall trees under electric distribution lines, etc.)

Continue to select suitable species and place trees appropriately to minimize conflicts with infrastructure along streets (e.g., signs, traffic signals, streetlights).

Objective 3.2. Increase the use of large-canopy trees where practical to maximize tree benefits relative to costs.

Actions

Include large-statured trees in planting plans for parks, streets, and other public lands where practical.

Objective 3.3. Locate new tree plantings in areas that will maximize energy conservation in buildings and shading of pavement.

Actions

Provide homeowners with information on how to place trees to maximize energy conservation.

Use the planning and design review processes to encourage the use of parking lot and streetscape designs that provide greater amounts of pavement shading.

2.2. Tree and forest health

Issues and trends

- Greater genetic diversity within the urban forest reduces the risk of serious pest and disease epidemics. Genetic diversity can be increased by using multiple tree species and by using trees that are of seedling origin. Trees grown from seed are more genetically diverse than trees that are propagated clonally (grafted or grown from cuttings) and are consequently genetically identical. Most named tree varieties are genetically identical clones.
- A few tree species and varieties, such as flowering pear varieties, constitute a higher-than-optimal percentage of all publicly-managed trees (Sections 3.3, 3.4), but efforts are now being made to increase genetic diversity in both new and replacement public right-of-way streetscape plantings.
- Because much of Rocklin has been developed recently over a fairly short time period, even-aged stands of trees make up large portions of Rocklin's urban forest. Within these stands, trees with similar life spans will reach the end of their useful life as a group.
- Water conservation will continue to be a regional issue, especially during periods of drought. Currently, about a third of City-maintained trees along parkways are drought-tolerant.
- Soil conditions in many parts of Rocklin pose moderate to severe limitations on tree growth and survival (Section 6.4). Trees planted in difficult sites and trees that are poorly adapted to Rocklin's soil and climate conditions will tend to be short-lived and/or may develop pest and disease problems.
- Some publicly-owned woodlands along creeks have been invaded to varying degrees by aggressive non-native species that may displace native riparian vegetation (Section 3.2).
- Native oak woodland stands are subject to "genetic pollution" from non-local oaks planted nearby. This may reduce the fitness of seedlings in the native stands and interfere with natural regeneration (Section 3.5).

Goal 4. Maintain trees in a healthy and safe condition.

Objective 4.1. Institute a program for identifying and correcting tree-related hazards on public properties.

Actions

Develop a program for locating and evaluating potentially hazardous trees on public lands and public rights-of-way.

Objective 4.2. Follow best management practices for tree planting and care for trees on public land.

Actions

Monitor tree health on public lands (parks, streets, open space areas, and public buildings) to identify developing pest and disease problems.

As needed, update the list of tree species potentially suitable for landscape uses in Rocklin to reflect new pest problems that may render a tree unsuitable for continued planting.

Plant good-quality, preferably locally-grown, disease-free nursery stock to increase long-term survival. Implement the use of updated tree nursery stock standards to ensure the use of good quality stock. Continue existing pre-and post-planting inspections conducted by City staff, and implement new inspections where necessary for trees planted on public lands.

Continue use of current ANSI or other nationally-recognized pruning standards for pruning conducted by City staff and tree care contractors.

Develop and implement standards for assessing and improving (if necessary) soil conditions prior to planting to improve long term tree health and survival.

Assess and remediate site conditions prior to replanting trees which have died. Do not replant sites that are determined to be unsuitable for tree planting.

Objective 4.3. Encourage the use of best management practices (BMP) for tree planting and maintenance for trees planted on private lands.

Actions

Continue existing pre-and post-planting inspections conducted by City staff, and implement new inspections where necessary for trees planted on private lands as a condition of project approval.

Continue current City practice of accepting calls from private property owners about unusual tree pest or disease problems and, if warranted, inspecting affected trees as a way to identify new problems.

Make BMP guidelines for tree planting and maintenance available to permit applicants and the general public to encourage better tree selection, planting and care.

Goal 5. Develop an urban forest canopy that is stable over the long term.

Objective 5.1. Avoid excessive use of individual tree species or varieties within large plantings and within the urban forest as a whole.

Actions

Establish upper limits for the percentage of the tree population that a single variety or species should comprise within planning areas or citywide. This will minimize the exposure of

the urban forest to damage by new diseases, pests, or problems that affect only a single species or variety. Use these percentages to aid in species selection for new and replacement tree plantings.

Where possible, substitute trees of different species or varieties for overused species/varieties when planting new or replacement trees.

Objective 5.2. Maximize the effective age diversity of plantings to avoid even-aged stand problems.

Actions

In new plantings where even age plantings cannot be avoided, use a mix of species with different useful life spans. For example, oaks may live for well over 100-150 years whereas flowering pears may have a maximum useful life closer to 30-50 years.

When planting replacement trees, avoid using trees that will reach the end of their useful life at the same time as existing trees in the planting.

Objective 5.3. Increase the percentage of drought-tolerant trees in Rocklin's urban forest.

Actions

Increase compliance with existing policies that emphasize the use of drought tolerant trees in new plantings.

Increase the use of locally-native oaks, especially blue oak, in new landscape plantings.

Reduce or eliminate the use of trees with high water use requirements in harsh sites such as street tree plantings and parking lots.

Increase the overall percentage of drought tolerant trees in City street tree plantings and in parks and private development by using more drought tolerant species in new and replacement plantings when feasible.

Objective 5.4. Protect the long-term viability of conserved native oak woodlands in Rocklin.

Actions

Use only trees of local genetic stock in and near native oak stands to conserve the genetic integrity of local oak populations.

Reduce cover of invasive exotic plant species in riparian woodlands.

Avoid using invasive exotic plant species in landscape situations to prevent escape of these plants into natural areas. Maintain a "do not plant" list for landscape plan review purposes.

2.3. Management of the urban forest

- Most publicly-managed trees in Rocklin are young and in relatively good condition. Tree care costs are likely to rise somewhat as trees become larger. Both the Department of Public Works and the Parks Division of the Department of Community Services and Facilities maintain City-owned trees (Sections 3.3, 3.4).
- Rocklin will reach residential buildout around 2015. Once residential development is complete, there will be fewer payments into the Oak Tree Preservation Fund.

- The majority of the trees in Rocklin's urban forest are on privately-owned lands. Most property owners want to protect their trees, but many lack knowledge of currently-accepted tree care practices.
- Currently, City goals for tree planting and oak tree conservation are addressed primarily through the actions of the Planning Department. Through the City's development review process, the Planning Department implements Rocklin's Oak Tree Preservation Ordinance and General Plan Goals and Policies that affect the urban forest.
- Once development is completed, responsibility for care and maintenance of planted trees and conserved oak woodlands shifts to other departments (Public Works and the Parks Division of the Community Services and Facilities Department), or to private individuals. Maintenance of additional public trees will require additional maintenance staff (Public Works and Parks Division) and/or more contracted tree care services.

Goal 6. Promote efficient and cost-effective management of publicly-owned urban and natural forest resources.

Objective 6.1. Develop a systematic approach to inspect and prune City-maintained trees in an efficient manner.

Actions

Develop appropriate criteria for inspecting and pruning trees of various species and size classes present in City-maintained landscapes.

Inspect and, as needed, prune young trees that will become medium to large-statured as needed (generally no more frequently than every 2 to 3 years) to establish good structure and avoid later remedial pruning.

Inspect and, as needed, prune mature trees on an appropriate schedule to maximize cost-efficiency (generally no more frequently than every 5 to 7 years).

When financially feasible, develop a tree inventory system to track tree care.

Objective 6.2. Increase coordination and communication between City departments/divisions whose activities affect the urban forest.

Actions

Foster communication and feedback between Planning, Public Works, and Parks and Facilities staff who deal with tree-related planning and maintenance issues.

Formally review the City tree list at least every two years and update as necessary.

Review the management plan, tree planting and maintenance guidelines, and public information brochure portions of this document every five years and update as necessary.

Develop management plans for maintaining specific sectors of the City's urban forest (e.g., parks, street segments, riparian corridors, open space areas). Formally review these management plans every 5 years and update as needed.

Continue and expand tree care training / education opportunities for City staff involved in tree maintenance and landscape planning.

Objective 6.3. Develop basic budget information on costs associated with maintaining and caring for the community forest.

Actions

Track costs associated with maintaining parkway and park trees to ensure assessment districts will provide adequate funding as trees mature.

As part of the City's annual budget process, prioritize necessary maintenance and preservation activities to be funded through sources other than the Oak Tree Fund. Where possible, apply for external grants to leverage City funding.

Periodically compare relative cost-efficiency of in-house versus contracted tree care for planting, young tree care, and mature tree care. Use these data to ensure that tree care tasks are allocated to contractors or City staff in a cost-efficient manner.

Goal 7. Foster community support for the local urban forestry program and encourage good tree management on privately-owned properties.

Objective 7.1. Institute an ongoing program to educate the public about tree selection, placement and care.

Actions

Provide locally-appropriate technical tree care information to residents through a variety of media to emphasize good tree selection and placement, optimal planting techniques, proper pruning of young and mature trees, and care of conserved native oaks.

Disseminate information about appropriate management of the residential/open space interface to landowners that are adjacent to public open space lands.

Encourage participation of local groups in public tree planting and tree care projects.

If local support exists, assist in the development of a tree-related non-profit / volunteer organization that can obtain grant funding for tree planting, tree care, and public education.

Provide funding, as feasible, for additional City staff time needed to carry out this objective. Alternatively, contract with a local tree non-profit to provide public outreach and volunteer coordination services.