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Guidelines for Tree Planting to Reduce Atmospheric Carbon Dioxide in Chula Vista, CA

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I. BACKGROUND

Urban forests can reduce atmospheric CO_2 in two ways. Trees directly sequester CO_2 as woody and foliar biomass while they grow. Also, trees around buildings can reduce the demand for heating and air conditioning, thereby reducing emissions associated with electric power production. On the other hand, CO_2 is released by vehicles, chain saws, chippers, and other equipment during the process of planting and maintaining trees. Eventually, all trees die and most of the CO_2 that has accumulated in their woody biomass is released into the atmosphere through decomposition. Chula Vista's urban forest can become an important sink for CO_2 through tree planting and stewardship that increases canopy cover and through strategic planting that cools urban heat islands and saves energy used for air conditioning.

Carbon Dioxide Storage and Sequestration

Carbon dioxide storage refers to the accumulation of woody biomass as trees grow over time. The amount of CO_2 stored at any one time by urban trees is proportional to their biomass and influenced by the amount of existing tree canopy cover, tree density, and the pattern of tree diameters within a city (McPherson, 1994). For example, in heavily treed Sacramento, CA CO_2 storage is 172 t/ha (McPherson, 1998), while in more sparsely treed Oakland, CA it is 40 t/ha (Nowak, 1993).

Carbon dioxide sequestration refers to the annual rate of storage of CO_2 in above-and below-ground biomass over the course of one growing season. Sequestration depends on tree growth and mortality, which in turn depends on species composition and age structure of the urban forest. Sequestration can range from 16 kg /yr (35 lb) for small, slow-growing trees with 8-15 cm d.b.h. (3-6 inches diameter at breast height) to 360 kg/yr (800 lb) for larger trees growing at their maximum rate.

Avoided Power Plant Emissions

Tree shade (direct effect) reduces summer air conditioning demand, but can increase heating energy use by intercepting winter sunshine. Lowered air temperatures and wind speeds from increased tree cover (indirect effect) decrease both cooling and heating demand. The total direct and indirect benefit from three trees around a typical Chula Vista residence can reduce annual cooling costs by $30 (270 kWh), equal to 330 lbs of avoided CO_2 emissions.

Regional variations in climate and the mix of fuels that produce energy to heat and cool buildings influence potential CO_2 emission reductions. Chula Vista's coastally influenced climate is temperate, so energy consumed to heat and cool buildings is relatively small compared to inland locations. On the other hand, San Diego Gas and Electric's (SDG&E) CO_2 emissions factor is 1.24 lb CO_2 / kWh, a relatively high value given the California state average of 0.76 lb CO_2 / kWh. Because SDG&E's power plant emissions are relatively high in CO_2, savings from avoided power plant emissions can be substantial for Chula Vista.

Carbon Dioxide Release

To provide a complete picture of atmospheric CO_2 reductions from tree planting it is important to consider CO_2 released into the atmosphere through tree planting and care activities, as well as decomposition of wood from pruned or dead trees. The combustion of gasoline and diesel fuels by vehicle fleets, and equipment such as chainsaws, chippers, stump removers, and leaf blowers is a relatively minor source of CO_2. Typically, CO_2 released due to tree planting, maintenance, and other program related activities is about 2-10% of annual CO_2 reductions obtained through sequestration and avoided power plant emissions.

Urban trees are usually removed soon after they die and are frequently recycled as landscape mulch or sold as firewood. Burning of tree wood results in nearly complete release of stored CO_2, while the rate of release associated with the decomposition of mulch is much slower depending on local climate and soil conditions (about 2-3 cm/yr in California). Decomposition of urban waste wood that is disposed of in landfills can take decades. Wood salvaged for use in wood products survives fifty years on the average, before becoming landfill and gradually decomposing (Norse, 1990). The amount of CO_2 released through decomposition from dead trees is directly related to tree survival rates. Management practices that increase survival rates and longevity will reduce and delay the release of CO_2. The amount of CO_2 released through decomposition of wood pruned from trees depends on pruning frequency and intensity. A study of residential greenspace in Chicago found that about 15% of the CO_2 sequestered each year was released back to the atmosphere through decomposition of woody biomass pruned from trees and shrubs (Jo and McPherson, 1995). By selecting tree species that are well adapted to their site in terms of size and growth the need for pruning can be minimized.

II. GENERAL GUIDELINES FOR RESIDENTIAL YARD TREES

Location

The right tree in the right spot saves energy. In midsummer, the sun shines on the east side of buildings in the morning, passes over the roof near midday, then shines on the west side in the afternoon. Air conditioners work hardest during the afternoon when temperatures are highest and incoming sunshine is greatest. Therefore, the west side of a home is the most important side to shade. Sun shining through windows heats the home quickly. Locate trees to the side of windows so that they block incoming solar radiation but don't block views. In Chula Vista, high fog in the morning sometimes limits sunshine that can warm the home early in the day. Consequently, the east side is the second most important side to shade.

Although the closer a tree is to the home the more shade it provides, the roots of trees that are too close can damage the foundation. Branches that impinge on the building can make it difficult to maintain exterior walls and windows. Keep trees at least 5-10 feet from the home to avoid these conflicts but within 30-40 feet to effectively shade windows and walls.

During winter the sun is lower in the sky and shines on the south side of homes. The warmth the sun provides is an asset so don't plant evergreen trees that will block southern exposures and solar collectors. Use solar friendly trees to the south because the bare branches of these deciduous trees allow most sunlight to strike the building (some solar *unfriendly* deciduous trees can reduce sunlight striking the south side of buildings by 50%). To maximize summer shade and minimize winter shade, locate trees about 10-20 feet south of the home.

Paved patios and driveways can become heat sinks that warm the home during the day. Shade trees can make them cooler and more comfortable spaces.

Shading your air conditioner can reduce its energy use, but don't plant vegetation so close that it will obstruct the flow of air around the unit.

Keep trees away from overhead powerlines and don't plant directly above underground water and sewer lines. Contact your local utility company before planting to determine where underground lines are located and which tree species will not grow into power lines.

Selection

The ideal shade tree has a fairly dense, round canopy with limbs wide enough to partially shade the roof. Given the same placement, a large tree will provide more building shade than a small tree. Deciduous trees allow sun to shine through leafless branches in winter. Plant small trees where nearby buildings or powerlines limit aboveground space. Columnar or upright trees are appropriate in narrow side yards.

When selecting trees match the tree's water requirements with those of surrounding plants. For instance, select low water-use species for planting in areas that receive little irrigation. Also, match the tree's maintenance requirements with the amount of care different areas in the landscape receive. Tree species that drop leaves and fruit may be more easily maintained in areas where litter disappears in course groundcovers or in a lawn where it can be easily raked up than in areas that are more difficult to clean.

III. GENERAL GUIDELINES FOR TREES IN PUBLIC PLACES

Location and Selection

Locate trees in common areas, along streets, in parking lots, and commercial areas to maximize shade on paving and parked vehicles. Shade trees reduce heat that is stored or reflected by paved surfaces. Large trees can shade more area than smaller trees, but should be used only where space permits.

Because trees in common areas and other public places may not shade buildings, CO_2 reductions are primarily due to sequestration. Fast growing trees sequester more CO_2 initially than slow growing trees, but this advantage can be lost if the fast growing trees die at younger ages. Large growing trees have the capacity to store more CO_2 than do smaller growing trees. To maximize CO_2 sequestration select tree species that are well-suited to the site where they will be planted. Use information in the Tree List and references to assist with selecting the right tree for your site. Trees that are not well-adapted will grow slowly, show symptoms of stress, or die at an early age. Unhealthy trees do little to reduce atmopsheric CO_2, and can be unsightly liabilities in the landscape.

Contact your local utility company before planting to locate underground water, sewer, gas, and telecommunication lines. Note the location of powerlines, streetlights, and traffic signs and select tree species that will not conflict with these aspects of the citys' infrastructure. Keep trees at least 30-ft away from street intersections to insure visibility. Avoid planting shallow rooting species near sidewalks, curbs, and paving. Tree roots can heave pavement if planted too close to sidewalks and patios. Generally, avoid planting within 4-ft of pavement, and remember that trunk flare at the base of large trees can displace soil and paving for a considerable distance. Select only small-growing trees (< 25-ft tall) for locations under overhead powerlines and don't plant directly above underground water and sewer lines. Avoid locating trees where they will block illumination from street lights or views of signs in parking lots, commercial areas, and along streets.

Maintenance requirements and public safety issues influence the type of trees selected for public places. The ideal public tree is not susceptible to wind damage and branch drop, does not require frequent pruning, produces little litter, is deep-rooted, has few serious pest and disease problems, and tolerates a wide range of soil conditions, irrigation regimes, and air pollutants. Because relatively few trees have all these traits it is important to match the tree species to planting site by determining what issues are most important on a case by case basis.

For example, parking lot trees need to be tolerant of hot, dry conditions, have strong branch attachments, and not attacked by pests that leave vehicles covered with sticky exudate. Consult the Tree List and other references noted at the end of the List for information on these tree traits.

Parks and other public landscapes serve multiple purposes. Some of the guidelines listed below may help you maximize their ability to serve as CO_2 sinks:

- Provide as much pervious surface as possible since soil and woody plants store CO_2.
- Maximize use of woody plants, especially trees, as they store more CO_2 than do herbaceous plants and grass.
- Increase tree stocking levels where feasible and immediately replace dead trees to compensate for CO_2 lost through tree and stump removal.
- Create a diverse assemblage of habitats, with trees of different ages and species, to promote a continuous canopy cover.
- Select species that are adapted to local climate, soils, and other growing conditions. Adapted plants should thrive in the long run and consume relatively little CO_2 through maintenance.
- Group species with similar landscape maintenance requirements together and consider how irrigation, pruning, fertilization, weed, pest, and disease control can be minimized.
- Compost litter fall and apply it as mulch to reduce CO_2 release associated with irrigation and fertilization.
- Where feasible, reduce CO_2 released through landscape management by using push mowers (not gas or electric), hand saws (not chain saws), pruners (not gas/electric shears), rakes (not leaf blowers), and emploing local landscape professionals who don't have to travel far to your site.
- Consider the project's life span when making species selection. Fast growing species will sequester more CO_2 initially than slow growing species, but may not live as long.
- Provide a suitable soil environment for the trees in plazas, parking lots, and other difficult sites to maximize initial CO_2 sequestration and longevity.

IV. ESTABLISHING HEALTHY TREES FOR LONG TERM BENEFITS

Inspect your tree at the nursery or garden center before buying it to make sure that it is healthy and well formed. Check for matted roots by sliding off the plastic container or feeling down the side of it. Roots should penetrate to the edge of the rootball, but not densely circle the inside of the container or grow through drain holes. Avoid trees with dense surface roots that circle the trunk and may girdle the tree.

Dig the planting hole the same depth as the rootball so that the tree will not settle after it is watered in. The crown of the tree should be slightly above ground level. Make the hole two to three times as wide as the as the container. Backfill with the native soil unless it is very sandy, in which case you may want to add composted organic matter such as peat moss or shredded bark.

Use the extra backfill to build a berm outside the rootball that is 6 inches high and 2-3 feet in diameter. Soak the tree and gently rock it to settle it in. Cover the basin with a 4-inch thick layer of mulch, but avoid placing mulch against the tree trunk. Water the new tree twice a week for the first month and weekly thereafter for the next couple growing seasons. Stop watering once regular winter rains begin.

Inspect your tree several times a year and contact a local landscape professional if problems develop. By keeping your tree healthy, you maximize its ability to reduce atmospheric CO_2 and provide other benefits.

V. QUANTIFICATION OF POTENTIAL CO_2 REDUCTION BENEFITS OF THE URBAN FOREST IN CHULA VISTA

Savings estimates for CO_2 avoided through energy savings, sequestration and tree care activities are given in this section. Energy use for heating, which can be both positively and negatively effected by trees, is not considered due to Chula Vista's mild winters.

Cooling Energy Savings and Avoided CO_2

Yard trees. Cooling energy savings from shade (direct effects) for a medium-sized tree (approximately 24 ft spread and height) 15 years after planting are based on results of computer simulations (McPherson and Sacamano, 1992; Simpson and McPherson, 1996) for a 1,500 ft^2 residence in San Diego (California Energy Commission climate zone 7) built after 1980. Their results are scaled up for a 2,070 ft^2 structure, which is the typical conditioned floor area for this vintage home (Ritschard et al., 1992). Resulting annual cooling energy use for the unshaded base case is about 550 kWh ($60). Savings 15 years after planting for trees 15 ft from the building are 36% (200 kWh, $22) for 3 trees (2 on west, 1 on the east side of the residence). For 2 trees on the west savings are 31% (170 kWh, $19). After 15 years, savings from a single large (33 ft height and spread), medium (24 ft tall), and small (18 ft tall) tree on the west are 147 kWh ($16, 183 lb CO_2), 123 kWh ($14, 153 lb CO_2), and 62 kWh ($7, 77 lb CO_2), respectively.

West trees generally produce the largest savings from shade. Trees located to east or south produce 45 - 50% of the savings of those to the west (Table 1). Other locations generally produce smaller savings. For example, we weighted savings calculated for all trees strategically planted for energy conservation through Sacramento Shade by the frequency distribution of trees at each location, and found that savings for the "average" tree were approximately 30% of those from an optimally placed west tree (Simpson, 1998).

Cooling energy savings due to air temperature and wind speed reduction (indirect effects) accrue to a neighborhood or larger area from an aggregate increase in canopy cover. We estimate these savings to be about 0.5% reduction in annual air conditioning energy use per 1% increase in canopy cover based on results reported in the literature. Given that the average tree crown projection area is calculated to be 600 ft^2 15 years after planting, and if we assume an average residential lot size of 10,000 ft^2, average canopy cover increase/tree is 6%. Savings/tree are found as the product of (annual cooling energy use) x (percentage savings/1% cover change) x (% cover change/tree). Assuming three trees per residence throughout a neighborhood area, we estimate savings from 12 to 26 kWh per tree, and 36 to 78 kWh per residence. Indirect effects should only be attributed to a particular tree if it is part of a tree planting that is increasing tree cover in the surrounding neighborhood.

Common area trees. Common area trees are assumed to be further than 50 ft from residences, so they provide no savings from shade. Indirect savings for these trees are treated the same as yard trees, since they are contribute to the overall increase in tree cover in an area.

Avoided CO_2, monetary savings, and per capita emission offsets. CO_2 emissions avoided due to energy savings resulting from tree shade and microclimate modification are found as the product of energy savings above with the CO_2 emission factor for San Diego Gas and Electric, 1.24 lbs CO_2/kWh of electricity (Table 1). The monetary value of energy savings given in these tables assumes an electricity cost of $0.11/kWh.

We calculate the number of trees required to offset average annual CO_2 emissions. Average annual emissions are assumed to be 15,811 lb/capita based on Chula Vista's 1990 inventory.

CO_2 Sequestration and Release

Yard trees. Sequestration, the net rate of CO_2 storage in above and below ground biomass over the course of one growing season, is estimated for medium-sized trees 5 (13 ft height and spread), 10 (19 ft tall), and 15 (24 ft tall) years after planting (Table 1). Annual reduction in CO_2 15 years after planting for 3 medium-sized trees is 3 x 384 = 1,152 lbs. CO_2 releases are considered to be small compared to sequestration and avoided CO_2, and aren't considered here.

Common area trees. We assume similar growth rates and CO_2 release rates for yard and common area trees, so sequestration rates for common area trees are equal to yard trees.

Change in Potential Benefits with Time

Potential CO_2 reductions due to direct and indirect energy savings and sequestration are plotted in the accompanying figure at 5 year intervals for a 40 year planning horizon for small, medium and large yard trees planted approximately 15 ft from the west-facing wall of a 2,070 ft^2 post-1980 residence. Estimated CO_2 releases from tree maintenance are also indicated. Sequestration is the major source of CO_2 reduction, reaching a maximum approximately 15 years after planting at the time of maximum tree growth rate, then decreasing as trees mature. Avoided CO_2 savings increase steadily over time, since energy savings are closely related to tree size, which varies both with tree age and mature size (large, medium or small). Maintenance releases are small and increase in magnitude very slowly with time.

Potential CO_2 reductions due to building shade (direct cooling) are approximately four times greater than due to air temperature reductions (indirect effects). This result reflects the fact that sunlight through windows is the predominant means of heat gain in Chula Vista. Heat gain due to warm air temperatures is relatively small due to the relatively mild climate.

Table 1. Annual values of energy and CO_2 reduction per tree for a medium-sized yard tree to the west, south, and east at 5, 10 and 15 years after planting. Values for common area trees assume no building shade.

Yard Trees

Direct + Indirect Effects

West tree

Years after planting	Sequestered CO_2 lbs	Energy savings $	Energy savings kWh	avoided CO_2 lbs	Total avoided CO_2 lbs	Offset [1] Trees/capita
5	165	2.70	24	30	195	81
10	328	8.70	79	98	427	37
15	384	13.50	123	153	536	29

South tree

Years after planting	Sequestered CO_2 lbs	Energy savings $	Energy savings kWh	avoided CO_2 lbs	Total avoided CO_2 lbs	Offset [1] Trees/capita
5	165	1.50	14	17	182	87
10	328	3.90	35	43	372	43
15	384	6.20	56	70	453	35

East tree

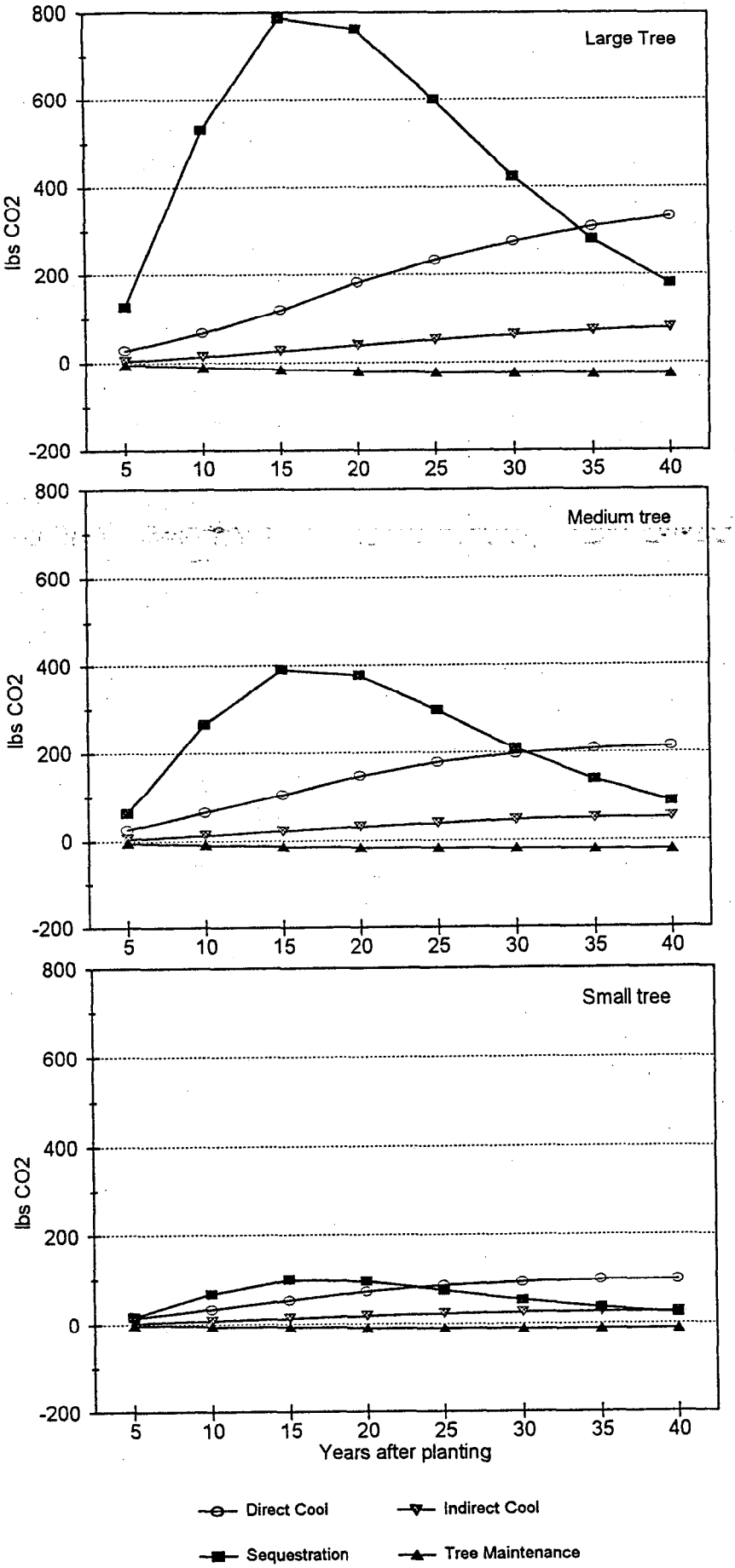
Years after planting	Sequestered CO_2 lbs	Energy savings $	Energy savings kWh	avoided CO_2 lbs	Total avoided CO_2 lbs	Offset [1] Trees/capita
5	165	1.70	15	19	184	86
10	328	4.10	38	47	375	42
15	384	6.60	60	75	458	34

Common Area Trees

Indirect Effects

Years after planting	Sequestered CO_2 lbs	Energy savings $	Energy savings kWh	avoided CO_2 lbs	Total avoided CO_2 lbs	Offset [1] Trees/capita
5	165	0.50	4	5	170	93
10	328	1.40	13	16	344	46
15	384	2.40	22	27	411	39

[1] Based on toal CO_2 emissions of 15,811 lbs per capita.


Large Tree
Medium tree
Small tree
lbs CO2
800
600
400
200
0
-200
5
10
15
20
25
30
35
40
Years after planting
Direct Cool
Indirect Cool
Sequestration
Tree Maintenance

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VII. SPECIAL CHARACTERISTICS OF SELECTED TREE SPECIES.

Tree Name	A Mature Height ft.	B Mature Spread ft.	C Type	D Solar Friendly	E Growth Rate	F Long-evity	G Cultivars Available	H Comments	I Suitability S=Street Y=Yard P=Park
Large Trees >50 ft. Height									
Alnus rhombifolia white alder	50-90	40	D-L	N	F	L	N	aphids, borers	S/Y/P
Eucalyptus citriodora, rudis, sideroxylon lemon-scented, desert gum, red ironbark eucalyptus	40-80	40-80	E-L	N	F	M	Y	litter	S/P
Fraxinus uhdei Mexican ash (appears well-adapted, good shade)	70	40-60	D-L	NDA	F	L	Y	shallow roots, frost sensitive	S/P
Liquidambar styraciflua sweetgum	60-75	35-50	D-L	N	M	L	Y	fruits, shallow roots	S/Y/P
Magnolia grandiflora Southern magnolia	60-80	30-40	E-L	N	M	L	Y	shallow roots, litter	S/Y/P
Pinus canariensis Canary Island pine	60-80	30-40	E-L	N	F	L	N	pine tip moth, litter	Y/P
Pinus pinea stone pine, Italian stone pine, umbrella pine	35-60	35-45	E-L	N	M	L	N	drought tolerant	P
Pinus torreyana torrey pine	40-60	40-50	E-L	N	F	L	N	native	P
Pistacia chinensis 'Keith Davey' (male clones) Chinese pistache (appears solar friendly, adapted)	60	25-35	D-L	NDA	M	M	Y	Verticillium	S/Y/P
Platanus acerifolia 'Yarwood' or *'Bloodgood'* London plane tree	70	50-70	D-L	N	F	L	Y	litter, mildew, anthracnose	S/P
Platanus x hispanica 'Columbia' Columbia London plane tree (disease resistent)	60	40-60	D-L	N	F	L	N	litter	S/P
Quercus agrifolia coastal live	40-60	40-60	E-L	NDA	M	L	N	acorns	S/P
Quercus ilex holly oak	40-50	40-50	D-L	N	M	M	N	acorns	S/P
Quercus suber cork oak	70	40	E-L	NDA	M	L	N	acorns	S/P

Tree Name	A Mature Height ft.	B Mature Spread ft.	C Type	D Solar Friendly	E Growth Rate	F Long-evity	G Cultivars Available	H Comments	I Suitability S=Street Y=Yard P=Park
Tristania conferta Brisbane box	50-70	30-50	E-L	N	M	L	Y	drought tolerant	S/Y/P
Umbellularia californica California laurel	40-60	40-60	E	N	S	L	N	native, drought tolerant	S/Y/P
Medium Trees 30-50 ft. Height									
Brachychiton acerifolius flame tree (appears solar friendly, well adapted)	35-50	25-30	D-M	NDA	F	L	N	litter, drought tolerant	S/Y/P
Brachychiton populneus bottle tree	35-50	25-40	E-M	N	M	L	N	litter, drought tolerant	S/Y/P
Cercidium x 'Desert Museum' (no thorns & better Desert Museum palo verde shade than *C. floridum*)	30	20-30	D-M	Y	F	M	Y	thornless, hard to obtain	S/Y/P
Cinnamomum camphora camphor tree	40-50	50-70	E-M	NDA	F	L	N	shallow roots, Verticillium	S/Y/P
Cupaniopsis anacardiopsis carrotwood	30-40	25-35	E-M	N	M	M	N	fruit	Y/P
Diospyros virginiana (male clones) persimmon (solar friendly, appears well adapted)	40-50	30-40	D-M	Y	M	L	Y	frequent pruning, fruit	Y/P
Geijera parviflora Australian willow	30-35	20-25	E-M	N	F	M	N	low maintenance	S/Y/P
Hymenosporum flavum sweetshade	40	15-20	E-M	N	M	M	N	protect from winds	S/Y/P
Jacaranda mimosifolia jacaranda	25-40	45-60	D-M	NDA	F	M	Y	litter	S/Y/P
Koelreuteria elegans (less litter and more attractive Formosan flame tree than other K. species)	35	35-50	D-M	NDA	F	M	N	hard to obtain	S/Y/P
Koelreuteria paniculata and bipinnata goldenrain and Chinese flame tree	30-40	30-40	D-M	Y	M	M	N	litter	S/Y/P
Paulownia tomentosa princess-tree (solar friendly, appears well adapted)	40-50	40-50	D-M	Y	F	M	N	litter	S/Y/P
Pyrus calleryana 'Trinity,' 'Chanticleer' Trinity and Chanticleer pear (best clones of species)	30	12-18	D-M	N	F	M	Y	fruit	S/Y/P

Tree Name	A Mature Height ft.	B Mature Spread ft.	C Type	D Solar Friendly	E Growth Rate	F Long-evity	G Cultivars Available	H Comments	I Suitability S=Street Y=Yard P=Park
Tipuana tipu tipu tree, pride-of-Bolivia	30-50	50-80	D-M	NDA	F	M	N	prune up, flower litter	S/Y/P
Ulmus parvifolia 'Athena', 'Allee' (tough shade tree, Chinese or lacebark elm best new clones)	50	25-35	D-M	NDA	F	S	Y	frequent pruning	S/Y/P
Small Tree < 30 ft. Height									
Arbutus unedo strawberry tree	10-30	10-30	E-S	N	S	M	Y	needs pruning, basal suckers	S/Y/P
Bauhinia spp. orchid-tree	20-30	20-30	E-S	N	M	M	Y	drought tolerant	S/Y/P
Cassia leptophylla golden medallion tree	20-25	20-30	E-S	N	F	M	N	fruit litter	S/Y/P
Cercis occidentalis Western redbud, California redbud	15-25	15-25	E-S	Y	M	M	N	single or multitrunk	S/Y/P
Chitalpa tashkentensis chitalpa (appears solar friendly, well adapted)	25	20-25	D-S	NDA	M	M	Y	litter, aphids drought tolerant	S/Y/P
Lagerstroemia indica x *L. faurei* clones crape myrtle (Catawba, Cherokee, Pecos, etc.)	20	6-10	D-S	Y	M	M	Y	needs training	S/Y/P
Prunus cerasifera 'Krauter Vesuvius' 'Thundercloud' purple leaf and Thundercloud plum	20-30	20-30	D-S	Y	M	S	Y	litter	S/Y/P
Pyrus kawakamii evergreen pear	20-30	20-30	E-S	N	F	M	N	aphids, fireblight	S/Y/P
Tabebuia avellanedae (*T. ipe*) pink trumpet tree (partly deciduous in winter)	20-30	20-30	D-S	NDA	M	M	N	drought tolerant	S/Y/P
Tabebuia chrysotricha golden trumpet tree	20-30	20-30	E-S	N	M	M	N	partly deciduous in spring	S/Y/P
Xylosma congestum shiny xylosma (tough tree for difficult sites)	15-30	15-30	E-S	N	M	M	N	needs training drought tolerant	S/Y/P

Key:
A: Mature tree height.
B: Mature tree crown spread.
C: Tree Type: D-L, Deciduous-Large (>50'); D-M, Deciduous-Medium (30-50'); D-S, Deciduous-Small (<30'); E-L, Evergreen Large (>50'); E-M, Evergreen-Medium (30-50'); E-S, Evergreen-Small (<30').

D: Solar Friendly trees provide Winter solar access as well as Summer shade; Trees numerically ranked based on crown density, time of leaf drop, time of leaf out, crown area and growth rate; NDA, No data available.
E: Growth Rate: F, Fast; M, Moderate; S, Slow. From Gilman, E.F. *et al*, 1996; Southern Trees, 2nd Ed.
F: Longevity: L, Long (>50 years); M, Medium (25-50 years); S, Short (<25 years).
G: Availability of cultivars Y=yes; N=no.
H: Important features that influence tree selection.
I: S= Street= difficult growing conditions in heavily used areas: median, streetside, commercial plaza and retail.
Y= Yard= less difficult growing conditions, less public, sometimes restricted space: residential yard, common areas in residential developments, commercial office.
P= Park= less restricted space, public use: parks, schools, cemeteries, commercial campus/industrial park.

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