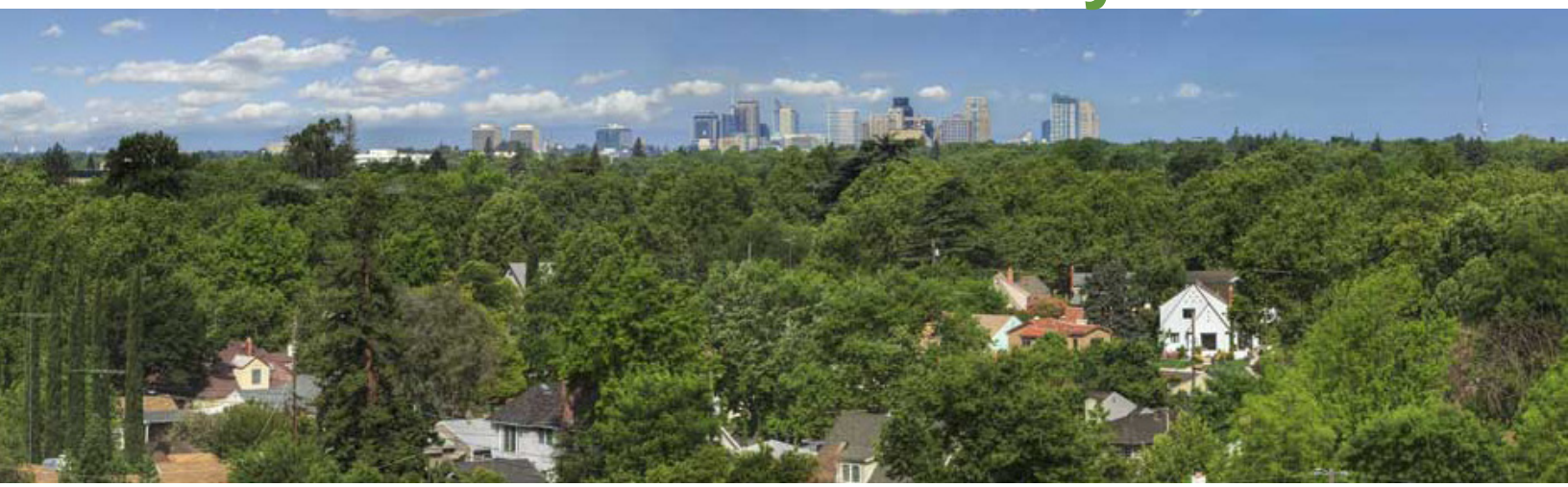
Chapter 3.2
Urban Forestry for Energy Conservation and Air Quality



Urban and exurban forest cover, including agroforests can improve air quality, reduce energy consumption, and produce biomass for energy production. Assessments should identify areas where management or restoration of the urban or exurban forest canopy will have significantly positive and measurable impact on air quality and produce substantial energy savings (excerpted from the U.S. Forest Service State and Private Forestry Farm Bill Requirement and Redesign Strategies).

KEY FINDINGS

Current Status and Trends

- The urban area (defined by the U.S. Census Bureau) in California encompasses about five percent of land and supports 94 percent of the total population and 93 percent of residential houses. The urban forest encompasses a broad area, including those areas dedicated to high density residential, commercial/industrial, transportation corridors and the wildland urban interface (WUI).
- *The State of the Air Report 2009* ranks counties for years 2005 to 2007 by high ozone days and particle pollution days. Particle pollution data was not reported for nine counties, and annual standards were not met in at least six counties. Thirty-six counties received a failing grade for high ozone when compared to the U.S. Environmental Protection Agency (EPA) ozone pollution standards.
- Urban areas have a high concentration of impervious surfaces and structures that likely contribute to the urban heat island effect.
- Urban forests reduce levels of carbon dioxide and other greenhouse gases and help mitigate the urban heat island effect. The Urban Forest Protocols were approved to benefit local governments and provide incentive to others through offset carbon credits for planting trees in urban settings.
- Many private companies, non-profit organizations and governmental programs have worked hard to sustain and improve California's urban forest. This strong network of organizations

provides many public benefits by improving the urban forest and by increasing public awareness of the importance of urban forests.

- Urban forestry adds jobs and economic value to the California economy. Preliminary data from new research conducted at Clemson University indicates that total output (sales) associated with the urban forestry industry in California was almost $5.4 billion in 2008. Employment totaled nearly 52,000 jobs and generated labor income of over two billion dollars. More economic value is generated through increased tax revenue estimated to be $246 million, and labor income estimated to be $2.9 billion (Templeton et al., 2009).

Urban Tree Planting for Energy Conservation and Air Quality

- About 800,000 densely populated urban acres (15.1 percent of California's urban area) have been identified with high threats from air pollution and urban heat islands.
- Close to 28 percent of the state's population (9.5 million people) live in high threat areas for air quality and urban heat.
- 372 communities have been identified as high priority planting areas to conserve energy or improve air quality.

Urban Tree Maintenance for Energy Conservation and Air Quality

- Close to 217,000 urban acres (about 4.3 percent of California's urban area) has been identified as densely populated with substantial existing tree canopy assets.
- Activities and projects to maintain and protect overall tree canopy would benefit the nearly two million people living in these areas.
- In some cases, a community may be identified as a priority landscape in both urban forest maintenance and tree planting because results are calculated for each quarter acre, but reported at an aggregated community level.

Bioregional Findings

- Extreme hot weather, measured by the number of days over 90 °F (32.2 °C), varies by geographic region. Generally, the Central Valley (interior portion of the Bay/Delta, Sacramento Valley and San Joaquin Valley bioregions) and the southern desert regions (South Coast and Mojave bioregions) are the hottest areas in California, with daytime temperatures exceeding 90 °F for 20 percent or more of the year, on average.
- The urban population continues to grow. Since 2000, the population has increased an average of one percent per year. California is divided into 58 counties with 70 percent of the total population residing in eight counties concentrated in the South Coast, Bay/Delta and Sacramento Valley bioregions. These high population counties include Los Angeles, Orange, San Diego, San Bernardino, Santa Clara, Riverside, Alameda, Sacramento, Contra Costa and Fresno.
- Priority landscapes for urban forestry are concentrated in the Central Valley and the inland southern portion of the state.
- Ranking priority communities can be problematic for resource allocation, given different outcome needs and the many ranking options available. Ranking based on population served may not consider the needs of smaller communities, while ranking based on community size class may not be the most efficient allocation of resources. Different options for community ranking should be considered when addressing specific program and community needs.

CURRENT STATUS AND TRENDS

The California urban forest is found in metropolitan areas that also support 94 percent of the population, and encompass about five percent (7,944 square miles, or approximately five million acres) of the land base. Urban areas are the most populated areas in the state as defined by the U.S. Census Bureau, and community boundaries may include both urban and some rural areas. See Table 3.2.1 for urban and rural population and acres by county.

Urban Forest as Community Infrastructure

The many benefits from urban forests have been well documented, and trees are generally recognized as a highly valued part of community infrastructure and environment. Urban trees benefit areas by providing recreation, pollution reduction, carbon storage, heat island mitigation, stormwater control, noise reduction and increased wildlife habitat. Increased property values and energy conservation are often found in an urban forest setting. Benefits vary with tree size, canopy cover and location, and are generally increased in hotter climates.

Activities associated with urban forestry add jobs and economic value to the California economy. Economic data for 2002 U.S. urban forestry tree sales and tree care services indicate that California led all states with a total output of tree production and care services valued at $2.1 billion and provided over 37,000 jobs. Public awareness and support has increased urban forestry efforts since 2002, providing additional added value in benefits, jobs and increased revenues.

The California Department of Forestry and Fire Protection (CAL FIRE) recently contracted with the Department of Applied Economics and Statistics at Clemson University, South Carolina to quantify the current impacts of urban forestry on the California economy. Preliminary data indicate that total output associated with the urban forestry industry in California was almost $5.4 billion in 2008. Employment totaled 51,971 jobs and generated labor income of more than $2 billion. Economic value added through increased tax revenue was estimated to be nearly $250 million and labor income estimated to be $2.9 billion (Templeton et al., 2009). The final report, expected by late September 2010, will include an

Urban tree cover providing shade in mixed residental/commercial neighborhood in Sacramento, CA
Source: Sacramento Tree Foundation, 2009

Table 3.2.1. Urban and rural areas by county (acres and population in thousands)

	Urban and Rural		Rural		Urban	
County	**Acres**	**Population**	**Acres**	**Population**	**Acres**	**Population**
Alameda	525	1,444	376	8	149	1,435
Alpine	474	1	474	1	<1	<1
Amador	388	35	384	22	4	13
Butte	1,073	203	1,016	37	57	167
Calaveras	663	41	658	33	5	7
Colusa	740	19	739	9	2	10
Contra Costa	514	949	346	20	168	929
Del Norte	649	28	638	9	11	19
El Dorado	1,145	156	1,101	58	44	99
Fresno	3,846	799	3,733	100	113	699
Glenn	849	26	844	12	6	15
Humboldt	2,294	127	2,265	38	29	88
Imperial	2,868	142	2,846	21	22	122
Inyo	6,545	18	6,540	8	5	10
Kern	5,224	662	5,101	78	123	584
Kings	891	130	868	17	23	113
Lake	851	58	837	26	14	32
Lassen	3,021	34	3,017	20	4	14
Los Angeles	2,528	9,512	1,655	68	873	9,444
Madera	1,378	123	1,353	42	25	81
Marin	378	247	315	14	64	233
Mariposa	936	17	936	17	<1	<1
Mendocino	2,248	86	2,230	40	18	46
Merced	1,266	211	1,227	36	39	175
Modoc	2,689	9	2,688	7	1	3
Mono	2,003	13	2,002	7	2	6
Monterey	2,121	402	2,057	44	64	357
Napa	506	124	483	20	23	104
Nevada	624	92	591	40	33	52
Orange	510	2,843	191	5	319	2,837
Placer	960	248	898	53	62	195
Plumas	1,673	21	1,672	18	1	3
Riverside	4,673	1,545	4,332	106	340	1,439
Sacramento	636	1,224	461	30	175	1,194
San Benito	889	53	882	12	8	41
San Bernardino	12,867	1,710	12,303	97	564	1,613
San Diego	2,712	2,811	2,197	110	515	2,701
San Francisco	69	777	38	<1	30	777
San Joaquin	913	564	829	56	83	508
San Luis Obispo	2,124	247	2,066	46	58	200
San Mateo	353	707	252	10	101	697
Santa Barbara	1,633	399	1,531	20	102	379
Santa Clara	835	1,683	640	21	195	1,662
Santa Cruz	286	255	240	38	46	217
Shasta	2,465	163	2,415	51	50	113
Sierra	615	4	615	4	<1	<1
Siskiyou	4,062	44	4,053	29	8	16
Solano	582	395	523	17	60	379
Sonoma	1,026	459	934	66	92	393
Stanislaus	970	447	893	40	77	407
Sutter	389	79	374	12	15	67
Tehama	1,893	56	1,880	28	13	29
Trinity	2,053	13	2,053	13	<1	<1
Tulare	3,099	368	3,032	69	67	299
Tuolumne	1,458	55	1,438	25	20	29
Ventura	1,173	753	1,043	24	130	730
Yolo	653	168	632	16	21	152
Yuba	412	60	401	18	11	42
Total	101,219	33,856	96,135	1,881	5,084	31,975

Note: County totals derived from estimating county total by 2000 Census block and urban data.

estimate of total jobs, value-added to the gross state product and other economic impacts associated with California urban forestry.

Urban Forest and Air Quality

Daily activities, including vehicle driving, mowing lawns, dry-cleaning clothes and natural occurrences such as wind blown dust and fires, cause air pollution. According to the EPA, the average adult breathes over 3,000 gallons of air every day. Children breathe even more per pound of body weight and are more susceptible to ill effects from air pollution. The elderly are also more sensitive to air pollution because they more often have heart or lung disease. The American Lung Association's *State of the Air Report (2009)* found that six out of 10 Americans live in counties where particle or ozone pollution has reached dangerous levels. The report ranked the top 25 most polluted cities in three pollution categories; short-term particulates, long-term particulates and ozone. California has some of the most polluted areas in the nation, holding title to the top four slots in each category and at least 24 percent of each category total.

Particulate matter (PM) in the air varies in size and comes in liquid and solid form. Particles less than 2.5 micrometers (PM 2.5) in diameter, 30 times smaller than the diameter of a single human hair, are called "fine" particles. Sources of PM 2.5 include dust from roads, agricultural operations, construction, wood burning and industrial activities. Exhaust emissions from mobile sources in California contribute a small amount to PM 2.5 emissions (California Air Resources Board, 2007). Recent studies have indicated that the PM 2.5 is considerably more dangerous than previously thought. In fact, researchers at Harvard University and the California Air Resources Board (ARB) have tripled their estimates of the number of deaths that occur each year from particulate matter (American Lung Association, 2009). From 2005 through 2007, at least six counties in California did not meet particulate pollution standards.

Ground level ozone is also a serious pollutant in urban areas, and is formed by chemical reactions between nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the presence of sunlight and heat. Ozone is more likely to form in warmer temperatures (Taha, 2005). For 2005–2007, 36 counties in California did not meet ozone standards according to EPA ozone measurements.

Trees can both add and reduce airborne VOCs. Trees naturally emit VOCs from their leaves, with emission rates varying by species and depending on ambient conditions. In general, the chemical reactions between NOx and VOCs that cause ozone to increase with higher temperatures. However, from the cooling effects of shading and increased evapotranspiration, trees generally lower local temperatures, and the net effect of increased tree canopy is usually to lower overall VOC emissions and ozone levels in urban areas.

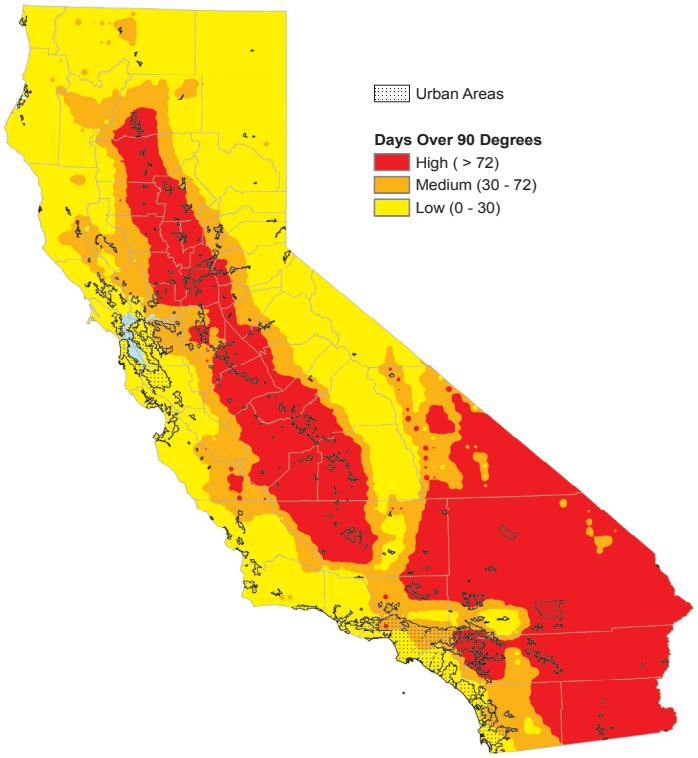


Figure 3.2.1.
California urban areas by annual average days over 90 °F.
Data Sources: Daily Temperatures, California Climate Action Team (2008); Urban Areas, U.S. Census Bureau (2000); USGS National Land Cover Dataset (2001)

Urban forests help filter out air pollutants through the interception of particulate pollutants on canopy leaves, sequestering of carbon dioxide in woody biomass and reducing air temperatures (McPherson, 1999). For example, trees in Sacramento County remove about 665 tons of ozone and 748 tons of particulate matter smaller than 10 micrometers (PM10) annually. The total value of ozone and particle pollution reduction is estimated at $28.7 million (U.S. Forest Service Center for Urban Forest Research, 2006). The value of these benefits is considerable across the state, and maximum results are achieved when the efforts and benefits are focused in highly populated areas.

Urban Forest and Energy Use

Population growth and the trend towards hotter summers have increased the need for electricity in California. In 2006, California produced 78.1 percent of the electricity it used; in 2007, that figure had dropped to 69.5 percent. Energy shortages and urban heat potential increase with urban development that adds impervious surfaces such as asphalt, concrete and roofs, which are estimated to cover 50 to 70 percent of urban areas (Taha et al., 1988).

While the climate varies around the state, the summers are generally hot for most areas away from the coast (Figure 3.2.1). The term "heat wave" is used to describe an event of three consecutive days of maximum temperatures above 90 °F (32.2 °C). Across the state, emergency room visits and hospital admissions increase due to heat related illnesses. Heat waves can be more of a threat to the health of the vulnerable, including children and those over 65 years of age (Natural Resources Defense Council, 2008).

With climate change, scientists are predicting more frequent heat waves for California, leading to increased energy demands and raising the risk of energy shortages and the possibility of rolling blackouts. When projected heat waves and energy demand were mapped with current energy supply, researchers found that shortages could be as high as 17 percent during heat wave periods (DOE, 2008). Shortages could present problems for California's urban population. In addition, impacts are amplified in urban areas because of the high percentage of impervious surfaces that increase local ambient temperatures.

Urban trees reduce summer air temperatures by providing shade and by absorbing water through their roots and evaporating it through their leaves in a process called evapotranspiration. Summer temperatures can be reduced 2–9 °F (1–5 °C) by evapotranspiration alone and shaded surfaces can be 20–45 °F (11–25 °C) cooler than unshaded materials (EPA, 2009; Akbari and Taha, 1992; Rosenfeld et al., 1998; McPherson and Simpson, 2003). Cooler building surfaces and walls then reduce the amount of heat transmitted into the air and the building, thus reducing air conditioning needs and energy demand.

EVALUATING URBAN AREAS FOR ENERGY CONSERVATION AND AIR QUALITY

This section evaluates heat- and pollution-related threats and tree assets in California's urban areas. Communities are identified where high value assets coincide with high threats of urban heat or energy use and air pollution. The high priority landscape (HPL) communities are those that could benefit the most from urban forestry efforts, including planting and maintenance, to improve air quality and reduce energy consumption and urban heat.

Two geographic information systems (GIS) models were used in this asset-threat based approach. The first model identified priority landscapes that would benefit from urban tree planting efforts. The second model identified priority areas where urban forestry efforts to protect existing tree canopy would be beneficial. The models differed in how tree canopy data was utilized. In the tree planting model, the absence of tree canopy was synthesized as a threat. In the maintenance model, existing tree canopy is synthesized as an asset.

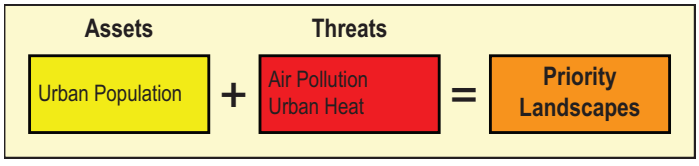
Resulting priority landscapes are concentrated in the Central Valley and inland southern portion of

the state. While results are depicted at a community level, ranking the communities for resource allocation is difficult because of different outcome needs and the many ranking options available. Ranking based on population served may not consider the needs of smaller communities, while ranking based on community size class may not be the most efficient allocation of resources. Ranking options should be considered when addressing specific program and community needs.

Analysis: Urban Tree Planting

High priority urban tree planting areas in California are densely populated areas with considerable air pollution, with high summer temperatures and urban heat islands (low tree canopy, high percent impervious surface and many days over 90 °F). Planting efforts can reduce the amount of energy consumption due to indoor cooling needs, help filter air pollutants and provide other public benefits.

Priority areas were identified by merging combined threats and assets. Areas in the high rank, due to the presence of both assets and threats, were considered priority landscape and targeted for urban forestry efforts. To allow the consideration of impacts and opportunities across various community sizes, and distribute resources more equitably, urban communities were sorted into five size class categories based on population. Areas in the highest ranks in each size class are considered priority landscape. To show another ranking option, the top 50 communities by population living in a high priority landscapes are also depicted. These rankings are not meant to be definitive, but rather approximations based on the best data available and the methods used in this analysis.



Assets

To support the goal of enhancing public benefit, the asset was defined as the urban population, representing where public health and energy conservation are significant potential concerns. Densely populated residential areas, those of at least five housing units per acre, were used to represent this. Commercial development also consumes a considerable amount of energy, and was also ranked as a high value asset.

Threats

For the purposes here, threats to the identified asset included air pollution and energy consumption. Data layers included urban areas (U.S. Census Bureau, 2000), air pollution (California Air Resources Board PM2.5 and ozone health data by county, non-attainment days PM10 by air basin), weather (daily temperature data from California Climate Action Team research for number days over 90°), percent impervious surface (National Land Cover Database (NLCD) percent coverage), road density, housing density class (U.S. Census Bureau, 2000) and tree canopy (NLCD percent coverage) for the planting model. Several steps were completed to synthesize this data.

Urban Heat

A single layer, depicting urban heat, representing areas of high energy consumption, was used for the planting model. Ranked data for impervious surface, tree canopy and weather (days over 90°) was combined. The higher ranks represent areas of more demand for energy (days requiring air conditioning) and the largest potential for urban heat.

Air Pollution

Air pollution was derived from PM10 air basin non-attainment days, county PM2.5 and ozone health data which were ranked and merged into one data layer. Health data (PM2.5 and ozone) has a greater overall influence as it presents greater health risks, and was given a weighted final rank. Final ranked data was as follows: high (county exceeds state averages), medium (county does not exceed state average, mid-values) and low (county does not exceed state average, low-values). Air pollution was

distributed by road density to create an urban pollution data layer; areas within 300 meters of an interstate, freeway or expressway were ranked high; low ranking areas within 150 meters of an urban principal arterial road were increased to medium rank.

Composite Threats
Urban pollution and energy consumption for interior cooling were merged into a single composite threat and categorically ranked high, medium or low vulnerability. Areas with high threats in both pollution and energy consumption were given the highest threat rank.

Results

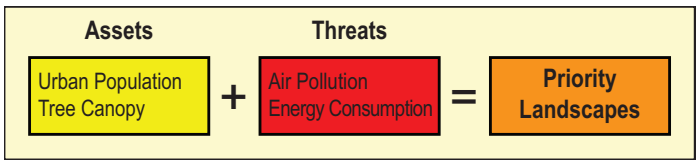
Priority planting areas for energy savings and air pollution reduction are depicted in Figure 3.2.2. Focusing on the 5.1 million acres of U.S. Census Bureau defined urban areas, 15 percent or 766,000 acres have been identified as high priority planting areas. The 2000 population estimates for these high priority landscape (HPL) communities is 9.5 million. Approximately 28 percent of the state population lives in these HPL communities. Most of the 372 HPL communities identified are located in the Central Valley and the inland southern portion of the state. About half of these communities had at least 25 percent of their total acres identified as high priority landscapes (HPL), 65 had more than 50 percent of their total acres in priority landscape and 22 had over 75 percent of their total acres identified as HPL. These HPL communities would benefit from activities and projects that increase overall tree canopy, to reduce energy consumption and improve air quality.

The top five communities for each size class are presented in Table 3.2.2. The communities in this table represent only 40 percent of the planting HPL population. All communities in this category should be considered for urban forestry planting efforts.

Next, Table 3.2.3 depicts the top 50 HPL communities using the population criteria, representing about 65 percent of the total planting HPL population.

Considerable public benefit could also be achieved by urban forest planting efforts in highly populated less threatened communities, and by maintaining existing tree canopy in highly populated communities that have existing tree canopy benefit from previous planting efforts.

Analysis: Urban Tree Maintenance



Assets

The maintenance model also contains the asset urban population, representing public health and energy conservation, which was measured by the proxy variable housing density. Commercial development generally consumes a large amount of energy, and was also ranked high. For the maintenance model, existing tree canopy coverage was combined with housing density to create a composite maintenance asset. Areas with high assets in both housing density and tree canopy were given the highest asset rank.

Threats

For the purposes of the model, threats to identified assets include air pollution and energy consumption. Data layers used included urban areas, air pollution (PM2.5 and ozone health data by county, non-attainment days PM10 by air basin), weather (number days over 90 °F), road density and housing density class. Several steps were completed to synthesize this data.

Energy Consumption
An energy use layer was created by first ranking areas by housing density and weather data. Areas with high housing density and many days over 90 °F were ranked highest.

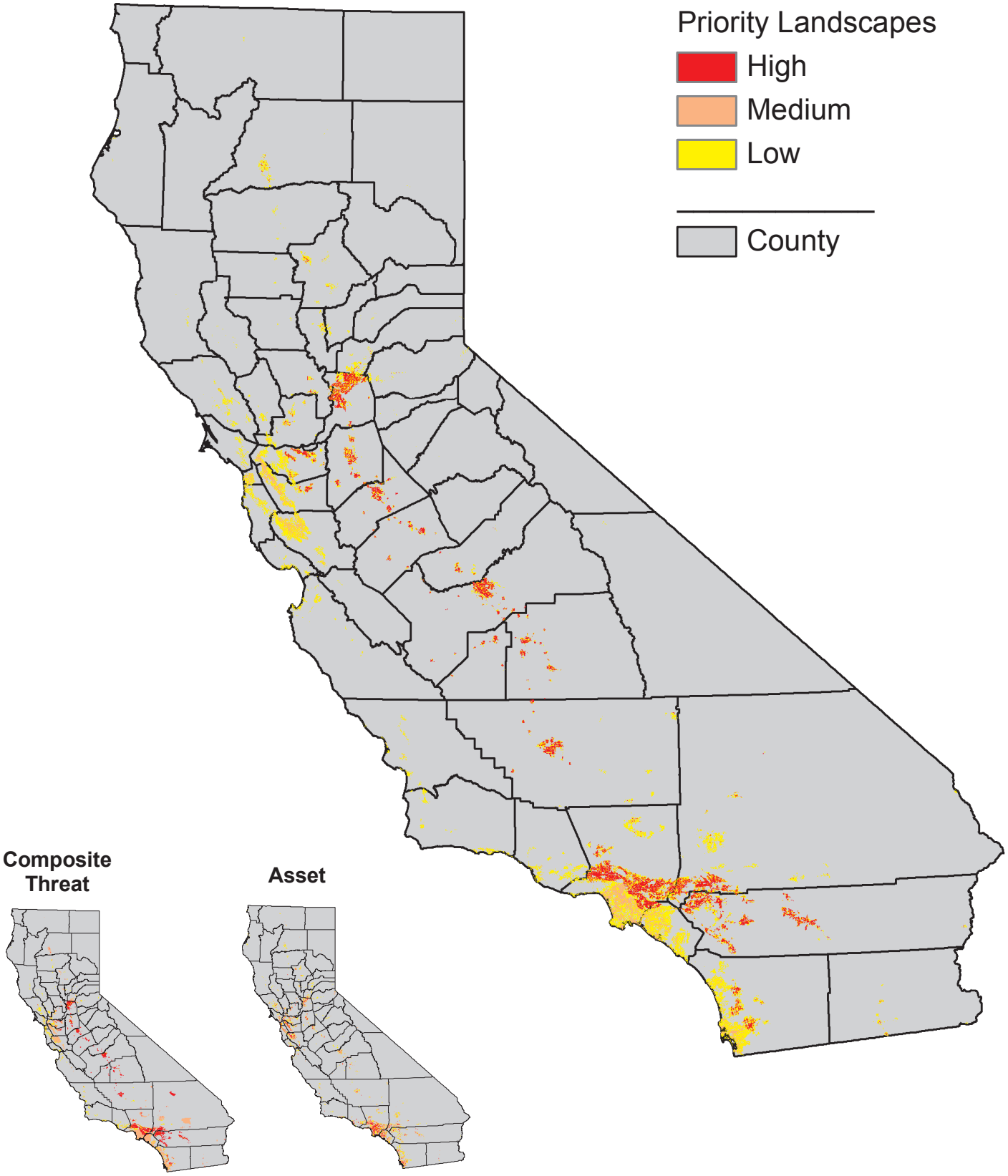


Figure 3.2.2.
Urban forestry planting priority landscape.
Data Sources: PM2.5 and Ozone Health, California Air Resource Board, (2009); Non-attainment Days PM10 by Air Basin, California Air Resources Board (2004-2008); Daily Temperatures, California Climate Action Team (2008); Functional Roads (FUNC), CALTRANS (2004); Urban Areas, U.S. Census Bureau (2000); National Land Cover Dataset, USGS (2001)

Table 3.2.2. Top five communities by size class: population in planting high priority landscape (acres and population in thousands)

Community	Total Acres	HPL Acres	HPL Percent	Population 2000	HPL Population	HPL Population Percent
Size Class 1 (≥ 250,000)						
Los Angeles	301	77	26	3692	1389	38
Fresno	71	33	46	430	378	88
Sacramento	63	26	41	406	306	75
Riverside	52	20	39	257	211	82
San Diego	210	8	4	1224	86	7
Size Class 2 (100,000–249,999)						
Bakersfield	79	20	26	244	209	86
Stockton	38	12	32	244	170	70
Glendale	20	7	34	195	160	82
Modesto	23	13	55	181	151	84
San Bernardino	38	12	31	188	143	76
Size Class 3 (50,000–99,999)						
Rialto	14	7	47	92	84	91
Visalia	23	9	38	95	82	87
El Cajon	9	5	56	95	81	85
Alhambra	5	4	76	85	79	92
Whittier	9	5	50	84	69	83
Size Class 4 (10,000–49,999)						
Manteca	11	4	40	50	43	87
Colton	10	3	32	48	42	87
Covina	5	3	71	48	41	87
Indio	19	4	23	50	41	83
La Mirada	5	3	58	47	41	87
Size Class 5 (< 10,000)						
Charter Oak	<1	<1	90	9	9	92
E. La Mirada	<1	<1	80	9	9	91
Canyon Lake	3	1	39	10	8	82
Exeter	2	1	55	9	8	85
Bystrom	1	1	48	9	8	84

Air Pollution

The air pollution threat data used here is the same as that used in the previous analysis, described above.

High Priority Maintenance Landscapes

Priority areas were identified by merging combined threats and assets, utilizing the same method as the planting model. High priority maintenance areas in California are those densely populated with people and trees, with many days over 90 °F and exceeding air pollution standards. Protecting the existing tree canopy in these areas provides public benefit.

Results

The priority landscape for urban forestry maintenance efforts are depicted in Figure 3.2.3. Focusing on the 5.1 million acres of U.S. Census Bureau defined urban areas, 217,000 acres or 4.3 percent has been identified as priority maintenance areas. Many of these communities already have areas with considerable tree canopy assets and urban forestry activities. Projects to maintain and protect overall tree canopy would be of benefit to the close to two million people living in these areas. Additional tree planting efforts should be targeted for areas of special concerns and to maintain overall health and canopy coverage of community trees.

Table 3.2.3. Top 50 communities by population in planting high priority landscape (acres and population in thousands)

Community	Total Acres	HPL Acres	HPL Percent	Population 2000	HPL Population	HPL Population Percent
Los Angeles	301	77	26	3,692	1,389	38
Fresno	71	33	46	430	378	88
Sacramento	63	26	41	406	306	75
Riverside	52	20	39	257	211	82
Bakersfield	79	20	26	244	209	86
Stockton	38	12	32	244	170	70
Glendale	20	7	34	195	160	82
Modesto	23	13	55	181	151	84
San Bernardino	38	12	31	188	143	76
Ontario	32	8	26	158	129	82
Moreno Valley	33	11	32	141	125	89
Fontana	26	9	36	142	122	85
East Los Angeles	5	4	76	125	116	93
Pomona	15	7	47	150	115	77
El Monte	6	4	70	115	105	91
Corona	25	8	32	128	100	78
Escondido	24	6	27	133	93	70
Burbank	11	5	47	100	89	88
Norwalk	6	4	69	103	87	84
San Diego	210	8	4	1,224	86	7
Santa Clarita	34	7	21	152	86	57
Pasadena	15	5	34	134	85	64
Rancho Cucamonga	26	8	29	128	85	66
Rialto	14	7	47	92	84	91
Visalia	23	9	38	95	82	87
West Covina	10	6	59	103	82	79
El Cajon	9	5	56	95	81	85
Alhambra	5	4	76	85	79	92
Whittier	9	5	50	84	69	83
Baldwin Park	4	3	72	76	68	90
Citrus Heights	9	7	74	84	67	80
Antioch	17	6	33	91	66	73
Arden–Arcade	12	7	53	97	66	68
Elk Grove	27	7	26	81	65	80
Clovis	14	6	45	69	59	86
Merced	13	5	40	64	58	91
Livermore	15	5	35	73	57	78
Pico Rivera	6	3	55	64	57	89
Montebello	5	3	55	62	55	89
Concord	20	5	26	121	55	45
Monterey Park	5	3	64	60	54	89
Hemet	18	6	35	59	52	88
La Habra	5	3	70	59	51	87
South Whittier	3	3	87	55	51	94
Turlock	10	5	48	56	50	89
Rosemead	3	3	78	53	50	93
Redlands	23	5	23	64	49	77
Temecula	19	5	27	67	49	73
Chino	19	3	18	70	47	68
Downey	8	3	39	107	46	43
Upland	10	4	42	69	45	65

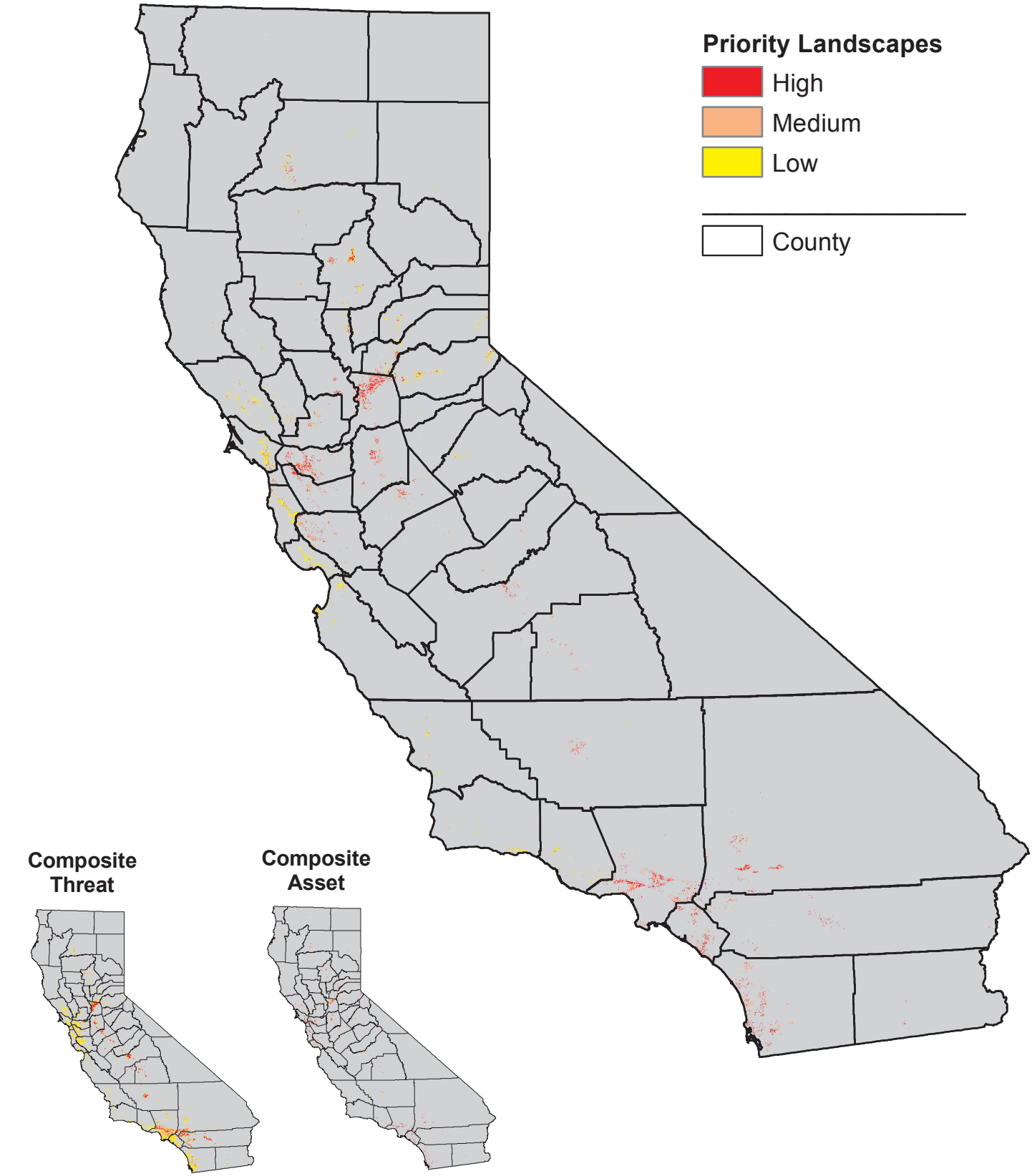


Figure 3.2.3.
Urban forestry maintenance priority landscape.
Data Sources: PM2.5 and Ozone Health, California Air Resource Board, (2009); Non-attainment Days PM10 by Air Basin, California Air Resources Board (2004-2008); Daily Temperatures, California Climate Action Team (2008); Functional Roads (FUNC), CALTRANS (2004); Urban Areas, U.S. Census Bureau (2000)

Table 3.2.4 depicts the top five maintenance HPL by community size class and population in HPL.

Table 3.2.5 depicts the top 50 priority areas for activities and projects to maintain overall tree canopy which can improve energy conservation and air quality.

Discussion

Priority landscapes for both models are concentrated in the Central Valley and inland southern portion of the state. While results are depicted at a community level, giving an ordinal rank to the communities is problematic for resource allocation because of the many ranking options. This chapter has depicted two of many options. Future strategies and policy will need to address how to allocate limited resources equitably and efficiently for maximum public benefit. A summary of population percent in each priority category by county is in Table 3.2.6 for county level comparison.

Past efforts appear to track along the priority landscape fairly well. With the exception of a few projects which may have focused on achieving other urban forestry benefits, a large percentage of past efforts has been focused in areas identified for planting effort to enhance public benefit while conserving energy and improving air quality. Figure 3.2.4 depicts past urban forestry efforts by tree planting priority landscape.

Table 3.2.4. Top five communities by size class: population in maintenance high priority landscape (acres and population in thousands)

Community	Total Acres	HPL Acres	HPL Percent	Population 2000	HPL Population	HPL Population Percent
Size Class 1 (≥ 250,000)						
Sacramento	63	12	18	406	156	39
Los Angeles	301	16	5	3,692	96	3
San Diego	210	9	4	1,224	62	5
Oakland	36	4	11	398	28	7
Fresno	71	2	3	430	25	6
Size Class 2 (100,000–249,999)						
Stockton	38	5	14	244	76	31
Modesto	23	3	12	181	35	19
Bakersfield	79	2	3	244	25	10
Pasadena	15	2	16	134	22	17
Berkeley	7	2	22	102	18	18
Size Class 3 (50,000–99,999)						
Arden–Arcade	12	5	39	97	41	42
Citrus Heights	9	2	27	84	25	30
Chico	21	2	10	76	23	30
Mission Viejo	12	2	19	88	19	22
Davis	6	1	22	60	18	30
Size Class 4 (10,000–49,999)						
Carmichael	7	3	39	50	21	43
Parkway–S. Sacramento	3	1	31	37	15	42
Paradise	12	4	36	26	15	56
Woodland	10	<1	10	49	13	27
North Highlands	8	<1	11	44	13	29
Size Class 5 (< 10,000)						
Lake Arrowhead	8	3	34	9	7	74
Country Club	1	<1	37	10	5	53
Placerville	4	<1	20	10	4	46
Lincoln Village	<1	<1	58	6	4	68
Running Springs	3	<1	34	5	4	73

Table 3.2.5. Top 50 communities in urban forest maintenance high priority landscape by percent of population (acres and population in thousands)

Community	Total Acres	HPL Acres	HPL Percent	Population 2000	HPL Population	HPL Population Percent
Sacramento	63	12	18	406	156	39
Los Angeles	301	16	5	3,692	96	3
Stockton	38	5	14	244	76	31
San Diego	210	9	4	1,224	62	5
Arden–Arcade	12	5	39	97	41	42
Modesto	23	3	12	181	35	19
Oakland	36	4	11	398	28	7
Fresno	71	2	3	430	25	6
Citrus Heights	9	2	27	84	25	30
Bakersfield	79	2	3	244	25	10
Chico	21	2	10	76	23	30
San Jose	113	2	2	894	23	3
Pasadena	15	2	16	134	22	17
Carmichael	7	3	39	50	21	43
Mission Viejo	12	2	19	88	19	22
Berkeley	7	2	22	102	18	18
Davis	6	1	22	60	18	30
Laguna Niguel	9	2	25	62	17	28
Fairfield	24	1	5	95	17	18
Lodi	8	1	14	57	17	30
Rancho Cordova	21	1	6	54	16	31
Walnut Creek	13	2	17	64	16	25
Parkway–S. Sacramento	3	1	31	37	15	42
Paradise	12	4	36	26	15	56
Redding	39	2	6	81	14	18
Woodland	10	<1	10	49	13	27
North Highlands	8	<1	11	44	13	29
Roseville	23	1	5	80	13	16
Riverside	52	2	3	257	13	5
Palo Alto	16	1	8	59	12	21
Vacaville	18	<1	5	88	12	13
Victorville	47	1	3	64	12	18
West Sacramento	15	<1	5	32	11	36
Elk Grove	27	1	4	81	11	14
Altadena	6	1	25	43	11	26
Fair Oaks	7	2	27	28	11	39
San Francisco	30	<1	2	777	10	1
Yuba City	9	<1	9	49	10	21
Anaheim	32	2	5	328	10	3
Glendale	20	2	8	195	10	5
Lake Forest	11	<1	7	78	9	12
Lafayette	10	2	20	24	9	39
Orinda	8	2	30	18	9	50
Pleasant Hill	5	1	24	33	8	26
Concord	20	<1	4	121	8	7
La Canada Flintridge	6	1	26	20	8	41
Folsom	14	1	8	52	8	16
Danville	12	1	12	42	8	19
Escondido	24	1	5	133	8	6
Oceanside	27	1	4	161	8	5

Table 3.2.6. Priority landscapes by percent of county population (population in thousands)

County	Percent of Population in Planting Priority Landscapes				Percent of Population in Maintenance Priority Landscapes				County Population
	Very Low	Low	Medium	High	Very Low	Low	Medium	High	
Alameda	4.2	33.7	57.3	4.8	94.0	0.0	0.5	5.5	1,444
Alpine	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	1
Amador	90.2	9.8	0.0	0.0	94.7	4.1	0.0	1.1	35
Butte	50.2	33.8	8.5	7.4	63.0	6.9	3.9	26.2	203
Calaveras	96.7	3.3	0.0	0.0	98.5	1.0	0.0	0.4	41
Colusa	63.5	36.5	0.0	0.0	85.1	8.5	1.4	5.0	19
Contra Costa	8.3	44.6	21.9	25.2	84.9	0.2	3.1	11.8	949
Del Norte	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	27
El Dorado	75.8	22.1	1.5	0.6	63.8	18.0	1.6	16.6	156
Fresno	17.4	8.7	0.0	73.9	91.6	0.2	3.4	4.8	799
Glenn	54.8	43.0	2.2	0.0	87.0	6.8	3.1	3.1	26
Humboldt	88.1	11.9	0.0	0.0	97.9	1.8	0.0	0.3	127
Imperial	31.9	40.1	17.7	10.3	85.0	0.3	0.6	14.1	142
Inyo	81.8	18.2	0.0	0.0	96.1	3.8	0.0	0.1	18
Kern	19.2	15.7	1.0	64.1	87.6	0.4	5.0	7.0	662
Kings	24.1	11.0	0.0	65.0	97.6	0.1	1.5	0.8	129
Lake	86.6	13.4	0.0	0.0	96.0	3.1	0.0	0.9	58
Lassen	97.5	2.5	0.0	0.0	97.4	2.0	0.0	0.5	34
Los Angeles	4.0	18.6	38.2	39.2	96.9	0.0	0.6	2.5	9,514
Madera	44.0	13.4	0.0	42.6	94.8	0.2	3.1	1.9	123
Marin	44.4	50.3	5.3	0.0	65.4	25.2	0.2	9.2	247
Mariposa	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	17
Mendocino	82.0	17.2	0.8	0.0	96.0	3.0	0.0	0.9	86
Merced	23.0	9.8	0.0	67.2	94.8	0.3	3.4	1.6	211
Modoc	100.0	0.0	0.0	0.0	99.8	0.2	0.0	0.0	9
Mono	100.0	0.0	0.0	0.0	88.7	11.3	0.0	0.0	13
Monterey	29.6	61.1	8.8	0.4	91.6	6.0	0.3	2.1	402
Napa	33.2	61.4	5.5	0.0	92.7	4.5	0.1	2.8	124
Nevada	94.3	5.0	0.8	0.0	78.8	17.1	0.0	4.1	92
Orange	3.7	48.0	44.7	3.5	95.4	0.0	0.5	4.0	2,845
Placer	41.8	40.7	12.6	4.9	75.7	6.0	4.7	13.5	248
Plumas	100.0	0.0	0.0	0.0	99.7	0.3	0.0	0.0	21
Riverside	12.8	14.8	0.4	72.1	96.7	0.0	0.5	2.8	1,545
Sacramento	5.8	20.5	0.0	73.7	55.9	0.6	12.7	30.7	1,224
San Benito	91.1	8.9	0.0	0.0	100.0	0.0	0.0	0.0	53
San Bernardino	12.4	28.1	2.8	56.7	94.5	0.2	0.6	4.7	1,710
San Diego	9.4	44.3	33.1	13.2	93.8	0.0	1.4	4.8	2,813
San Francisco	3.9	54.5	41.6	0.0	98.2	0.4	0.0	1.3	777
San Joaquin	15.6	20.0	2.2	62.2	68.3	0.7	9.2	21.9	564
San Luis Obispo	41.3	49.8	8.6	0.3	92.4	5.1	0.2	2.3	247
San Mateo	19.8	64.1	16.1	0.0	85.9	9.9	0.1	4.1	707
Santa Barbara	22.8	64.7	12.5	0.0	94.9	3.9	0.2	1.0	399
Santa Clara	5.7	47.6	46.7	0.0	95.0	0.0	1.0	4.0	1,683
Santa Cruz	39.8	52.2	8.1	0.0	82.9	13.4	0.5	3.2	256
Shasta	48.6	39.5	4.7	7.2	80.2	5.3	2.5	12.0	163
Sierra	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	4
Siskiyou	93.1	6.6	0.3	0.0	98.0	1.4	0.0	0.5	44
Solano	17.0	56.1	19.3	7.7	82.5	4.1	3.2	10.2	395
Sonoma	36.8	57.2	5.1	0.9	88.5	8.0	0.2	3.4	459
Stanislaus	13.9	11.3	0.6	74.2	80.6	0.4	8.1	10.9	447
Sutter	27.5	47.7	18.6	6.3	68.3	2.7	13.1	15.9	79
Tehama	65.3	34.1	0.6	0.0	90.9	4.0	1.1	4.0	56
Trinity	100.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	13
Tulare	25.1	9.9	0.0	65.0	92.0	0.3	4.1	3.6	368
Tuolumne	96.7	3.3	0.0	0.0	84.9	12.0	0.0	3.0	54
Ventura	16.7	71.6	11.6	0.0	96.4	2.7	0.1	0.7	754
Yolo	23.7	36.1	25.4	14.8	64.1	0.2	9.8	25.9	168
Yuba	46.9	48.0	5.1	0.0	84.5	7.6	3.8	4.1	60

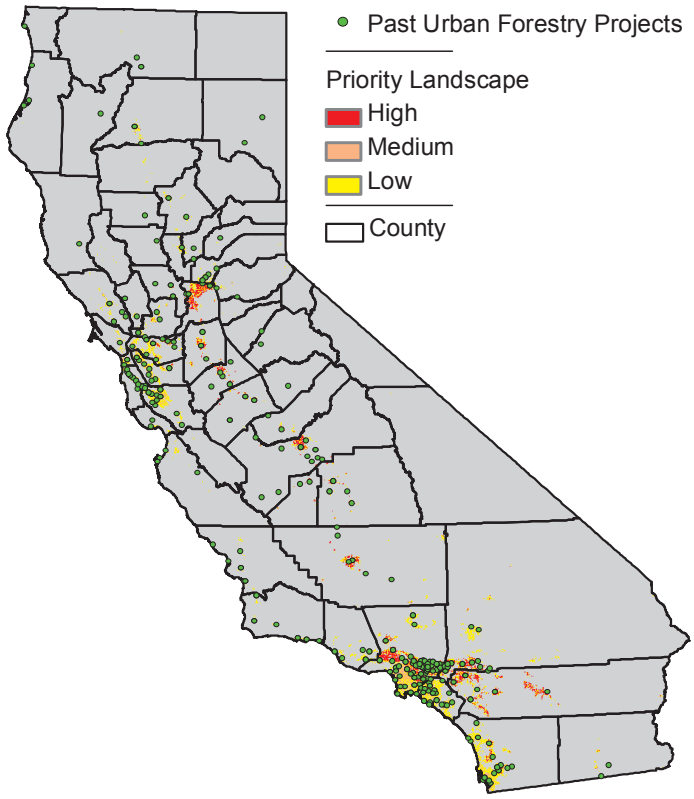


Figure 3.2.4.
Past urban forestry projects by tree planting priority landscape (Tree City USA 2006–2008 and CAL FIRE Urban Forestry Program 2002–2008).
Data Sources: PM2.5 and Ozone Health, California Air Resource Board, (2009); Non-attainment Days PM10 by Air Basin, California Air Resources Board (2004-2008); Daily Temperatures, California Climate Action Team (2008); Functional Roads (FUNC), CALTRANS (2004); Urban Areas, U.S. Census Bureau (2000); USGS National Land Cover Dataset (2001); Tree City USA (2008); CAL FIRE Urban Forestry Program (2008)

Tools

A wide range of approaches and programs now exist to deal with urban forests. For example, the purpose of CAL FIRE's Urban and Community Forest Program is to create and maintain sustainable urban forests to help improve the quality of urban environments and the quality of life of urban citizens.

Regional field specialists promote communication and cohesiveness. Working with local entities to establish integrated projects with multiple benefits, they are a key component to the efficient allocation of funds and the success of the program. They will also be the regional contacts for future Urban Forestry and Community Program tools which includes three broad categories: expansion/reforestation, maintenance/management and public outreach and support.

Expansion and Reforestation
Urban forest expansion is the planting of trees and associated vegetation in urban areas that will increase economic, environmental and social benefits to urban residents. Priority areas with considerable urban heat islands and low tree canopy should be targeted with planting and management efforts. Locating suitable tree planting sites becomes more challenging as open space and forests are lost to development as our population grows. Development without guidelines to conserve urban forests leads to decreased natural resources, and the increasing potential for urban heat islands, air pollution and increased stormwater flow associated with decreased water quality. American Forests, the nation's oldest nonprofit citizens' conservation organization, recommends an average 25 percent tree canopy for the dry west. Specifically, 18 percent tree canopy goal for urban residential, 35 percent suburban residential and nine percent commercial (Kollin, 2006). Expansion efforts can start with setting individual community tree planting goals and striving to meet them through various planned events such as Arbor Day, the Tree City USA campaign or a grant project. However, scarcer planting locations in both private and public areas have created a need to identify new expansion opportunities.

Expansion opportunities may be found by using urban forestry to support other planning goals. For instance, modifying traditionally impervious surfaces with pervious pavers and bioswales in parking lots; planting trees along road medians; adding green space above structures, such as green roofs and parks, all of these strategies help with stormwater runoff and reduce the urban heat island effect. As outdated urban areas and infrastructures are renovated and improved, the area can be retrofitted to accommodate some large-scale trees. Urban area freeway sound walls can become green walls that filter pollutants and noise.

Management

The urban forest encompasses a broad area including areas dedicated to high density residential, commercial/industrial, transportation corridors and wildland urban interface areas. Most definitions of urban forests now include both public and privately owned trees. Different management approaches can be utilized to manage and maintain this expanded urban forest. These approaches should be based on community goals, ownership, vegetation and risk assessment.

The loss of forests to urban development has had considerable environmental impacts including: loss of open space, wildlife habitat loss, water runoff, soil erosion, increased temperature and an increase in air pollution. Urban sprawl contributes to air pollution issues. Increase in the area of impervious surface due to new roadways and building hardscapes creates more water runoff, higher peak flows and soil erosion. Grading activities in conjunction with new development amplify the issue. Habitat is lost with urban development and infill housing projects. Management and maintenance of an urban forest is very complex because each community has goals and environmental concerns. Policies and ordinances that recognize the value of trees by providing guidance for inclusion, preservation and protection, are among the best means for managing and maintaining tree canopy cover.

Management tools also focus on environmental justice among communities to reduce inequitable distributions of environmental burdens, such as, pollution and heat islands caused by a lack of urban forests. Economically disadvantaged communities generally have fewer environmental amenities, more environmental burdens and less access to the decision making processes. Establishing plans in these communities often require more effort from the Urban and Community Forestry Program, because community leaders are often inundated with other issues, such as lack of resources and high crime and don't perceive planting trees a priority. However, increasing the urban forest in these areas can reduce energy bills, incidents of asthma and crime (Kuo and Sullivan, 2001a and 2001b).

Public Outreach and Support

Californians are increasingly aware of the importance of maintaining the environment and the state's natural resources, and actively support efforts to sustain our forestlands. In addition to the Urban Forestry Act of 1978, protection activities and awareness have increased and methods to protect and sustain our natural resources have been defined. Over the past decade, several propositions have been passed to ensure these resources are protected. In addition, Urban Forest Protocols were approved in 2008 to benefit local governments and provide incentive to others through offset carbon credits for planting trees in urban settings.

For any program to succeed and thrive it must have substantial support. This is especially true of the urban forestry program, which needs support from both private and public sectors. Communication, education and collaboration are key components to efficiency, and the planning of multiple benefit projects that endure future impacts and maximizes public benefits.

For urban development, this type of planning is referred to as "smart growth." Smart growth communities promote dense housing and walkable communities with the preservation of open space and planning of urban forest elements prior to development. The American Planning Association published a "Smart Growth Code" guide in 2009, which can be used by local governments, policymakers and developers interested in implementing smart growth strategies. Urban forestry tools of the future will support the smart growth concept, and promote policy to protect areas from being developed as sprawl. Small changes to development codes can have enormous impacts in an urban setting. Standards for minimum landscape requirements and impervious surface coverage allowance would be optimal, but hard to obtain. More achievable would be requirements for adequately sized planting strips on all new public development

that accommodate appropriate trees and shrubs and landscape requirements for residential projects.

Urban forestry tools of the future also include the support of new green industry jobs to aid conservation and sustainability, such as opportunities in generating and storing renewable energy, recycling materials and urban biomass and energy efficient and sustainable product development.