

# Past, present, and future: the urban forest of the San Francisco Bay area

## Urbanization in the Bay area

The nine-county area surrounding the San Francisco Bay is home to nearly 7 million people—a 30% increase in the last 20 years—and is expected to grow by more than 2 million people over the next 20 years. The amount of rangeland and farmland that has been transformed into urbanized areas, however, has been far greater than the population increase: 73% since 1984.

As increases in population drive urban growth, impervious surfaces increase the flow of contaminants into water bodies, air pollution increases from commuting traffic, and more energy is required to support new development. The **urban forest** works to mitigate these adverse effects by intercepting storm water, reducing and intercepting pollutant and greenhouse gas emissions, and helping to conserve energy.

## The project

To begin, we measured the amount of canopy cover and impervious surface in 1984, 1995, and 2002 using satellite imagery and remote-sensing technology and determined the changes over time. Next we calculated the ecosystem services and other benefits provided by the current urban forest. Finally we calculated the potential benefits associated with future increases in canopy cover.

## Changes in land cover

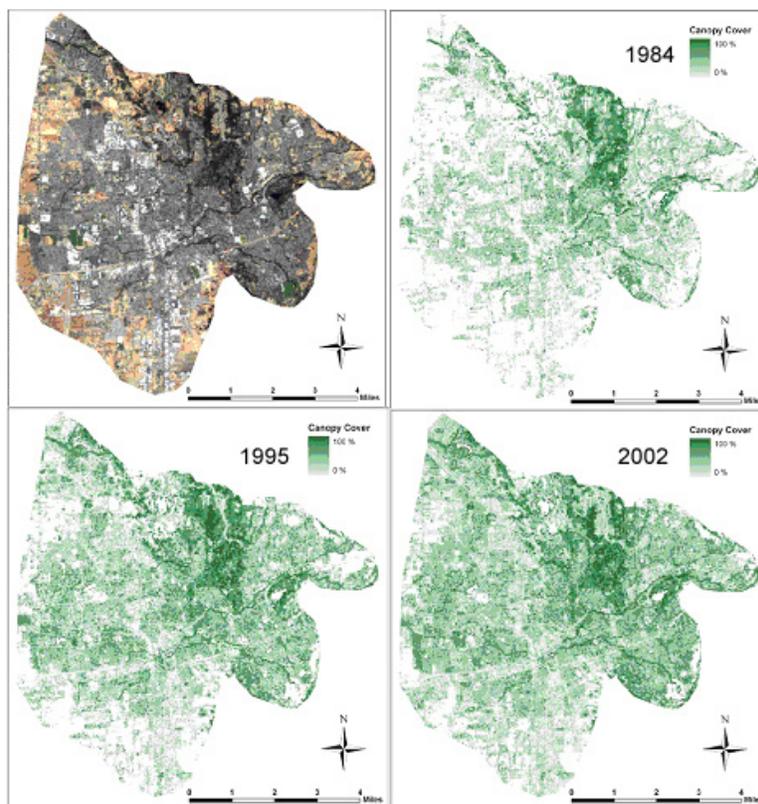
Between 1984 and 2002, the **urbanized areas** of the study region **increased** from 625 square miles to 1,080 square miles, a 73% expansion. Most of this growth occurred in San Jose, in areas east of the Oakland Hills, and the cities north of the Bay, including Napa and Sonoma counties. Because the cities of San Francisco and

Oakland were already largely urbanized, little change occurred there.

As people moved into areas that were historically farmland or ranchland, they planted trees and over time the trees have grown. Since 1984, these changes have **increased the canopy cover** of the study area by about 10%, bringing along many of the benefits of trees. Average canopy cover for the study area is 29%, ranging from 16% in San Francisco to 47% in Marin.

Unfortunately, at the same time, increasing development in our study area has also

meant **more impervious surfaces**, about 17% more. Impervious surfaces—roofs, parking lots, and roads—mean more polluted runoff entering our rivers, streams and the Bay; increased flooding; and less recharging of groundwater to supply us with drinking water and irrigation. Impervious surface accounts for 56% of the land cover of the study area.



As an example, the increase in canopy cover of Santa Rosa is shown between 1984 and 2002. *Top left* shows urbanized areas as of 2002.



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## Benefits of today's urban forest

Using data from five climate regions, three tree species mixes, six land uses, and our tree benefit models, we calculated the environmental and other benefits provided by the existing urban forest of the Bay area (approximately 300 square miles) as **\$5.2 billion!**

By shading built surfaces, transpiring water, and blocking cold winter winds, trees help us **save energy**. The trees of the Bay area's urban forest are estimated to reduce energy costs annually by more than \$330 million. As might be expected, these benefits are highest in the warmer counties with relatively more tree cover like Contra Costa and Santa Clara and lowest in San Francisco.

Trees **improve air quality** by intercepting and absorbing air pollutants, and by moderating the temperature, they reduce our consumption of energy and the amount of pollutants given off at power plants. Some species, however, can have detrimental effects on air quality by emitting one of the components of smog. The trees in our study area were estimated to improve air quality by approximately \$9 million every year.

By intercepting and storing rainwater on leaves and branches, the urban forest helps **protect the Bay**, clean our water, reduce runoff, and slow erosion. The trees in our study area intercept approximately 19 billion gallons of stormwater each year; these hydrology services are worth \$102 million.

Urban trees work in the **fight against global climate change** in two ways. First, they sequester carbon and transform it into leaves, branches, trunks

and roots. Second, by reducing energy consumption, they reduce the amount of carbon dioxide produced at power plants. The urban forest of the Bay area reduces atmospheric carbon dioxide levels by almost 600,000 tons a year, valued at almost \$4 million.

Many benefits attributed to urban trees are difficult to translate into economic terms, such as beautification, privacy, shade that increases human comfort, wildlife habitat, sense of place, and well-being. However, the value of some of these benefits may be captured in the property values of the land on which trees stand. In the nine-county San Francisco Bay area, these and other **"intangible" benefits** reflected in increased property values accounted for the greatest portion of the total benefits, \$4.7 billion.

## The urban forest of the future

As the Bay area continues to grow and change in the future, so will the urban forest. Increased tree planting, improved levels of tree care, and reductions in mortality can increase the region's canopy cover and increase the benefits residents receive.

We estimated the potential increase in benefits associated with 1.5, 3, 6, and 9% growth in canopy cover, all of which are feasible targets based on the levels achieved in other cities. Increasing canopy cover by these amounts would increase benefits 5 to 28% or \$237 million to \$1.4 billion dollars, bringing the total benefits to as much as **\$6.6 billion each year!** By investing in trees and tree care, residents of the nine counties of the San Francisco Bay area can enjoy the many ecosystem services that the urban forest provides.

**Annual benefits of the existing urban tree canopy of the nine-county San Francisco Bay area.**

County	Canopy cover (percent)	Hydrology (mi <sup>2</sup> )	Property value	Air quality	Carbon dioxide	Natural gas	Electricity	Total	
----- (thousands of dollars)-----									
Alameda	23.4	50.0	14,479	638,468	-7	723	4,583	32,139	690,384
Contra Costa	31.3	66.6	17,238	833,262	1,262	828	6,340	87,376	946,307
Marin	46.8	27.4	10,633	447,483	752	336	4,515	23,546	487,267
Napa	34.1	8.0	2,185	123,084	236	91	1,700	8,961	136,256
San Francisco	16.1	7.1	4,444	98,273	165	66	83	446	103,476
San Mateo	31.7	33.7	20,575	588,349	798	438	933	6,332	617,426
Santa Clara	28.9	76.9	21,821	1,411,399	4,630	950	1,514	94,611	1,534,925
Solano	22.7	17.8	4,569	205,552	297	219	1,670	20,961	233,268
Sonoma	33.7	23.5	6,475	377,377	712	288	6,042	31,053	421,947
<b>Total</b>	<b>29</b>	<b>311.1</b>	<b>102,419</b>	<b>4,723,247</b>	<b>8,844</b>	<b>3,940</b>	<b>27,380</b>	<b>305,426</b>	<b>5,171,256</b>

For more information on this and other urban forestry projects, visit: <http://www.fs.fed.us/psw/programs/cufr/>