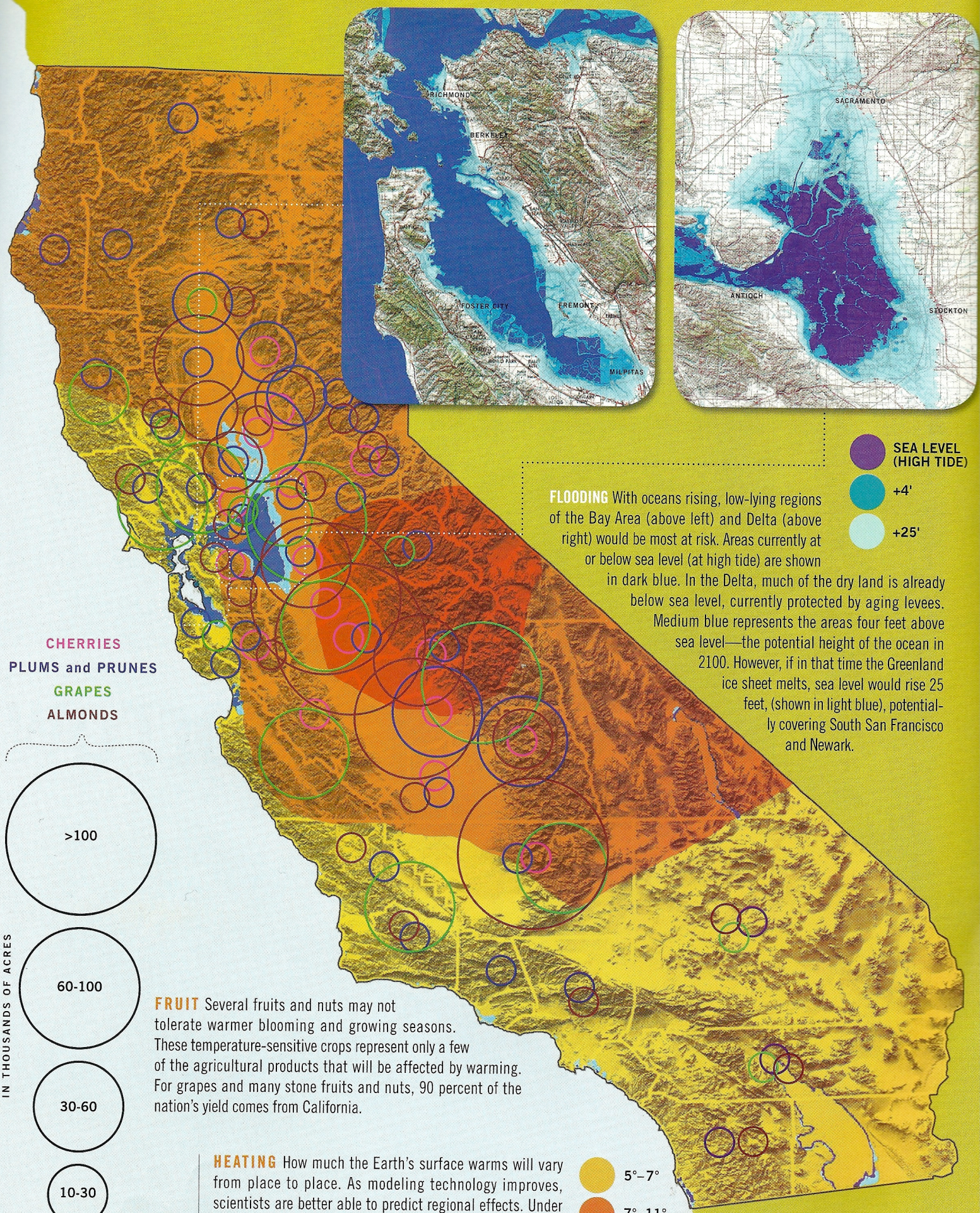


FLOODING With oceans rising, low-lying regions of the Bay Area (above left) and Delta (above right) would be most at risk. Areas currently at or below sea level (at high tide) are shown in dark blue. In the Delta, much of the dry land is already below sea level, currently protected by aging levees. Medium blue represents the areas four feet above sea level—the potential height of the ocean in 2100. However, if in that time the Greenland ice sheet melts, sea level would rise 25 feet, (shown in light blue), potentially covering South San Francisco and Newark.

FRUIT Several fruits and nuts may not tolerate warmer blooming and growing seasons. These temperature-sensitive crops represent only a few of the agricultural products that will be affected by warming. For grapes and many stone fruits and nuts, 90 percent of the nation's yield comes from California.

HEATING How much the Earth's surface warms will vary from place to place. As modeling technology improves, scientists are better able to predict regional effects. Under current CO_2 outputs, moderate projections show that by 2100 the entire state will warm, with Northern California and the Sierra seeing the largest temperature jumps.

SNOWICE PACK CHANGE DATA FROM GEOPHYSICAL RESEARCH LETTERS 2002; FRUIT DATA FROM THE USDA; HEATING DATA FROM PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, AUGUST 16, 2004

CALIFORNIA AT RISK

AGRICULTURE

Agriculture is at the nexus of global warming pressures in California. Mild weather and fertile soils make California the country's largest agricultural producer. But commercial farming depends on water that may become scarcer, stable weather that may become erratic, and moderate temperatures that are creeping up.

Until recently, most agricultural climate research focused on carbon dioxide. Because plants breathe in carbon dioxide, the thinking goes, elevated levels of the gas actually benefit many crops. But now agricultural scientists also have started considering temperature changes. California fruits such as blueberries and black currants won't flower until they've been in temperatures below 45 degrees for at least 150 hours, and most species require 500 hours or more. Stone fruits such as peaches, apricots, and cherries require anywhere from 200 to 1,500 "chill hours" every year. In Fresno County—an important fruit-growing region—there were about 830 chill hours this year, near the lower threshold of many crops. One study reports this number may go down further, affecting kiwis, walnuts, pistachios, nectarines, plums, apricots, and almonds.

Farmers also worry about the growing number of hot days per year. One of the most sensitive crops to this is the wine grape, which requires warm, moderate summer days and cool nights to produce sugars at an even pace. By 2100, California's moderate summers may pick up too many days above 95 degrees Fahrenheit for many wine grapes, crippling as much as 80 percent of U.S. wine production. Wine contributes $45 billion to California's economy through exports and tourism.

PACIFIC OCEAN

Some scientists speculate that warming ocean temperatures also could cause a continuous El Niño effect. El Niño is a pattern of ocean circulation that causes stronger storms in California, more hurricanes in the eastern Pacific, and droughts in parts of Asia every three to seven years.

In addition to having more El Niños, a warmer Pacific also would be higher. Rising ocean levels will put the Sacramento-San Joaquin River Delta at particular risk, because the land has subsided and much of it is now below sea level. The land is protected by an aging system of levees, which is fragile even at current ocean levels. Some 22 million Californians, including those in the Bay Area and Central Valley, get their water from the Delta, and if the ocean were to overwhelm the levees, that water supply would be contaminated with salt.

Trout and salmon favor cold water and are sensitive to slight changes in temperature. In California, many already live and breed at the upper end of their comfort zone, and studies suggest that some species could diminish by up to a third as temperatures rise. Fish populations also wax and wane with their food sources. Although some scientists say climate change should be a boon for carbon dioxide-loving algae, California oceanographers say 2006 has been a surprisingly weak year for the shrimp-like krill that many whales, seabirds, and fish feed on. The reason, some believe, is that global warming suppressed the cold-water upwelling that classically feeds California sea life.

HEALTH

In Los Angeles, an average of 165 people died per year during the '90s from heat-related illness. The Air Resource Board expects warmer temperatures to increase that number three- to sevenfold by the end of this century. Stroke, heart attacks, and breathing problems are also aggravated by warmer weather.

The debate is over. We know the science. We see the threat. We know the time for action is now. —Gov. Arnold Schwarzenegger upon signing the 2005 executive order establishing climate change emission reduction targets for California, the first such action in the United States.

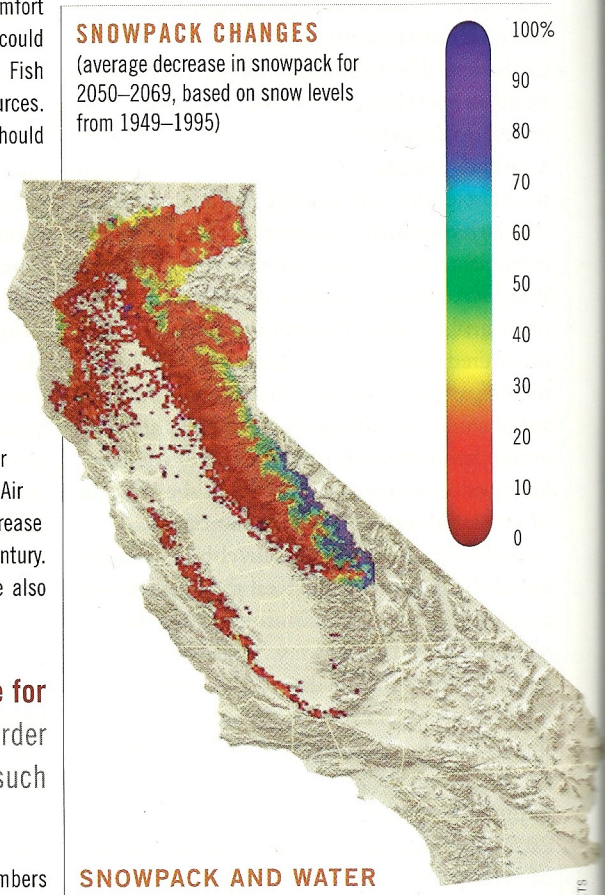
And as temperatures creep up, so do the numbers of parasites and diseases. West Nile virus, malaria, and dengue fever are all deadly diseases transmitted through warm-weather mosquitoes. West Nile in particular is carried by only a few types of the 53 California mosquito varieties. But those species are some of the most common in the state, and scientists say warmer weather aids their ability to spread disease. In 2004 and 2005, nearly 2,000 Californians caught the disease.

FORESTS AND FIRE

Until recently, many scientists assumed climate change would benefit forests because trees need carbon dioxide to grow. Indeed, many experiments show stronger growth from trees in a more carbon dioxide-rich atmosphere. But some California scientists say lower winter snow and hotter summer weather will thin tree cover, with an even harder hit to the $1.1 billion timber industry.

First, experts foresee a slow die-off of trees such as pine at lower elevations due to warmer weather. Then, as with the mosquitoes, warmer weather brings pests such as the fungus that causes pine pitch canker, a debilitating Southwestern tree disease. Combining these factors, as much as 18 percent of the state's forests could disappear, with some species dropping 30 percent.

Forest fires are also a natural consequence of hotter, drier forests. Last year alone, U.S. wildfires destroyed an area bigger than the state of Maryland. In the past three decades, scientists have studied increasing wildfires across California and now confidently link them to climate change.



SNOWPACK AND WATER

While snowpacks in the Alps and the Himalayas are shrinking, California snowpacks mostly are holding their own against rising temperatures. In fact, UC Santa Cruz scientists say Mt. Shasta's ice fields are some of the few growing temperate glaciers in the world. But the latest models don't see this continuing. A 3-degree-Fahrenheit rise in temperature may strip Sierra and Cascade snowpacks by a third, or enough water to supply 10 million homes. Models show most of the impact hitting the lower elevations, around western Lake Tahoe, for instance. They also show spring stream flows moving earlier in the year and evaporating faster.

But even with deep snowpacks, water in California has never been easy to come by. State regulators worry that with lower snowpack and more heat evaporation, water disputes will only worsen. On the Klamath River, for example, farmers, fishermen, environmentalists and Native Americans battle over the flows fed mostly by snowmelt. If that snowmelt decreases, the region could see even less of the precious water.