Tanoak mortality caused by *Phytophthora ramorum* in Western Marin County

○ CALIFORNIA
○ APRIL 2007

Forest Health *highlights*

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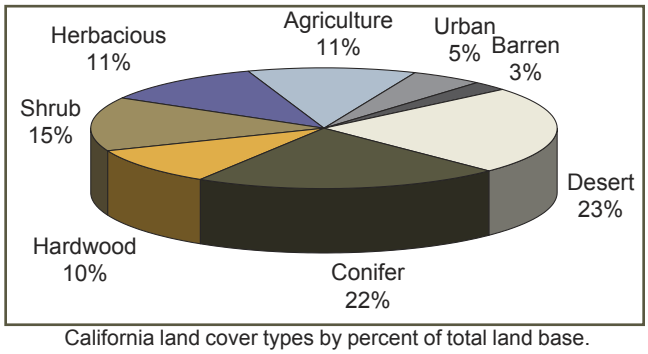
Forest Resource Summary

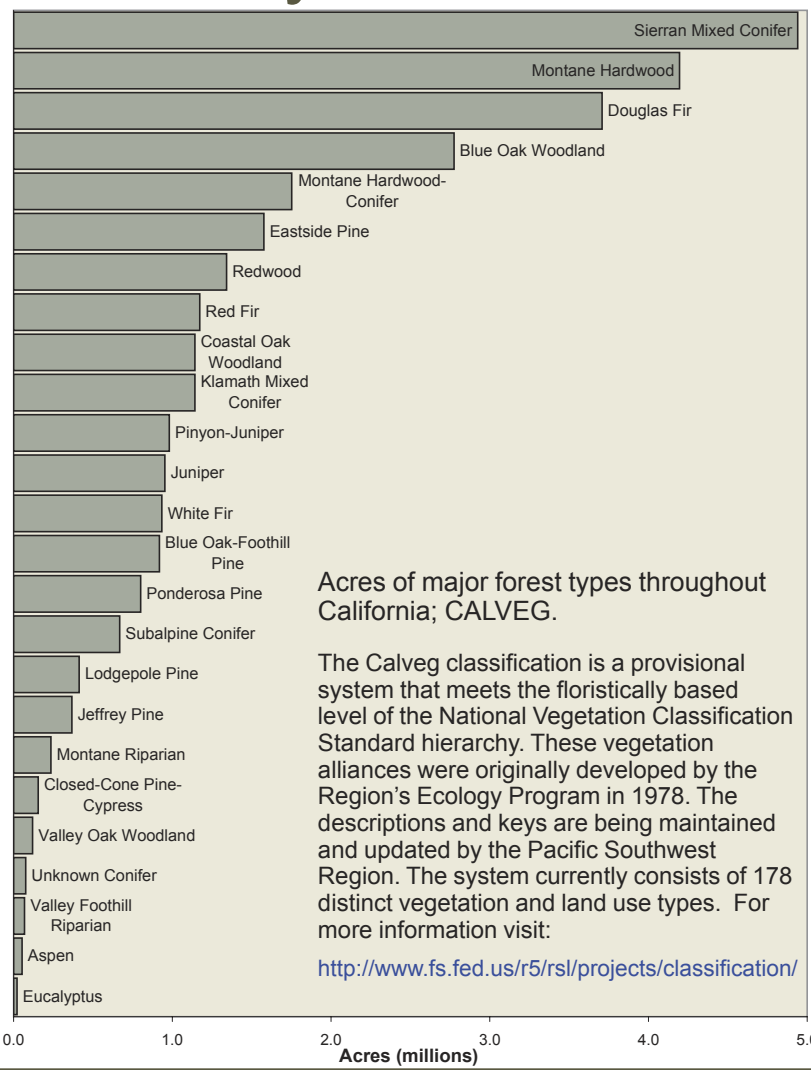
The USDA Forest Service and the California Department of Forestry and Fire Protection regularly map, measure, monitor and assess California's forested lands. California's forests are among the most complex and diverse in the nation, with 25 major forest types occurring over 32 million acres throughout the state.

Approximately 33% of California is forested. These forest resources are susceptible to a variety of forest pests depending largely on tree species composition, tree stocking, drought, air pollution and other environmental factors.



California land cover types by percent of total land base.

This report highlights of forest health conditions in California in 2006. Some of this information has been taken from the annual report of the California Forest Pest Council, *Forest Pest Conditions in California - 2006.* It does not purport to be a historic review or an in-depth consideration of any particular forest insect or disease organism or abiotic influence.



Acres of major forest types throughout California; CALVEG.

The Calveg classification is a provisional system that meets the floristically based level of the National Vegetation Classification Standard hierarchy. These vegetation alliances were originally developed by the Region's Ecology Program in 1978. The descriptions and keys are being maintained and updated by the Pacific Southwest Region. The system currently consists of 178 distinct vegetation and land use types. For more information visit:

http://www.fs.fed.us/r5/rsl/projects/classification/

National Forests of California

There are 18 National Forests in California, totaling over 20 million acres. These National Forests account for 25 percent of National Forest recreation nationwide and about half of the public wildland recreation in California. National Parks and other federal, state, county and private lands provide the remainder. http://www.fs.fed.us/r5/

Bark and Engraver Beetles

Jeffrey pine beetle activity increased on the east side of the Sierra Nevada range in 2006. Jeffrey pine beetle activity is expected to continue to increase in these areas in 2007, especially from Truckee, CA south along the eastern front of the Sierra Nevada range.

Drought related mortality associated with **mountain and Jeffrey pine beetle** in southern California continued to decline from the high levels observed in 2003. Activity continued at low levels in the San Bernardino, San Jacinto, and San Gabriel Mountains.

Mountain and western pine beetle activity remained low for the rest of the state in 2006, with the exception of the Modoc National Forest where mountain and western beetle-caused mortality was observed on ponderosa, lodgepole and whitebark pine on the Warner Mountain Ranger District.

Most of California experienced low to moderate levels of **fir engraver beetle** activity in 2006. However, fir engraver beetle-caused mortality in conjunction with overstocking, dwarf mistletoe, cytospora canker and annosus root disease continued at the same elevated levels seen in 2005 for few areas California. Elevated fir mortality continued on the Warner Mountain, Big Valley and Doublehead Ranger Districts, Modoc National Forest and throughout the entire red fir belt on the Tahoe National Forest. Fir mortality was also noted at higher elevations throughout the Sierra Nevada range.

Conifer mortality on Mount Bidwell, Modoc National Forest. Photo: Zachary Heath

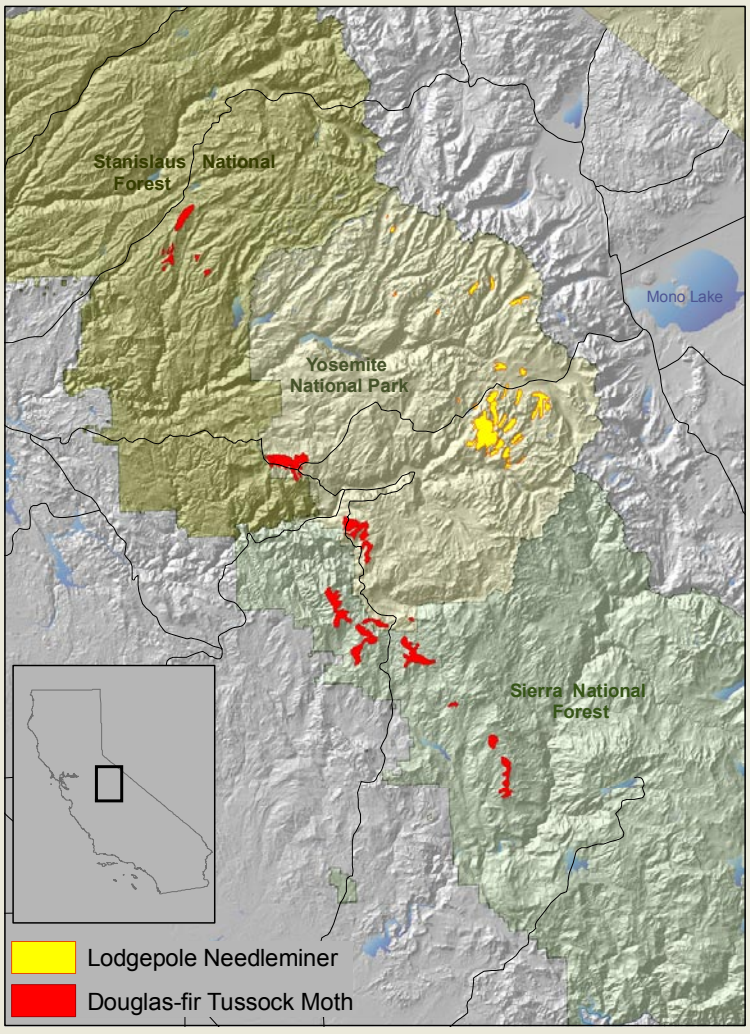
Defoliators

Defoliation from **Douglas-fir tussock moth** increased on the Sierra and Stanislaus National Forests and Yosemite National Park in 2006. Douglas-fir tussock moth was also detected in several new locations. There were about 40 acres of white fir defoliated on the Eldorado National Forest near Panther Creek. Defoliation was also detected on white fir and Douglas-fir further north on the Shasta-Trinity National Forest (1,783 acres defoliated) and on private land near Burney, CA (57 acres defoliated). Egg mass counts in this northern outbreak area indicate that some noticeable defoliation should be expected again in 2007.

Lodgepole needleminer defoliated nearly 14,000 acres of lodgepole pine on the eastside of Yosemite National Park. This is considerably lower than previous years. Over 30,000 acres of defoliation have been detected annually since 2003. Most of the defoliation was concentrated between Tenaya Lake and Cathedral Ridge in Tuolumne Meadows. Feeding appears to have tapered off in currently infested areas, and no lodgepole pine mortality was identified.

An **unknown leaf miner** was observed causing injury in black oak at a few locations on the Plumas and Tahoe National Forests. The highest defoliation levels were along Interstate 80 near Blue Canyon. Investigations to determine the cause of the leaf injury will continue in 2007.

Unidentified leaf miner injury.



2006 Douglas-fir tussock moth and lodgepole needleminer defoliation detected by the Aerial Survey Sketch Mapping Program.

Extensive mortality of coast live and Engelmann oak continued in 2006 in southern San Diego County. The mortality occurred around Descanso, Pine Valley, and in areas south of Interstate 8, including Horsethief Canyon, along Campo Road near Dutchman Canyon, and Lake Morena County Park. The cause for the widespread mortality is undetermined; investigations are continuing.

An unknown agent causing extensive mortality in live oak in southern San Diego County. Photo: Zachary Heath

Root diseases are a growing concern in southern California after the cutting of numerous bark beetle-killed trees. The potential for spread of **annosus root disease** will be a possibility for decades to come where freshly cut stumps were not properly treated. Specifically there is concern in the mountains of southern California where dead tree removal projects have been underway since the extreme conifer mortality events between 2002-2004.

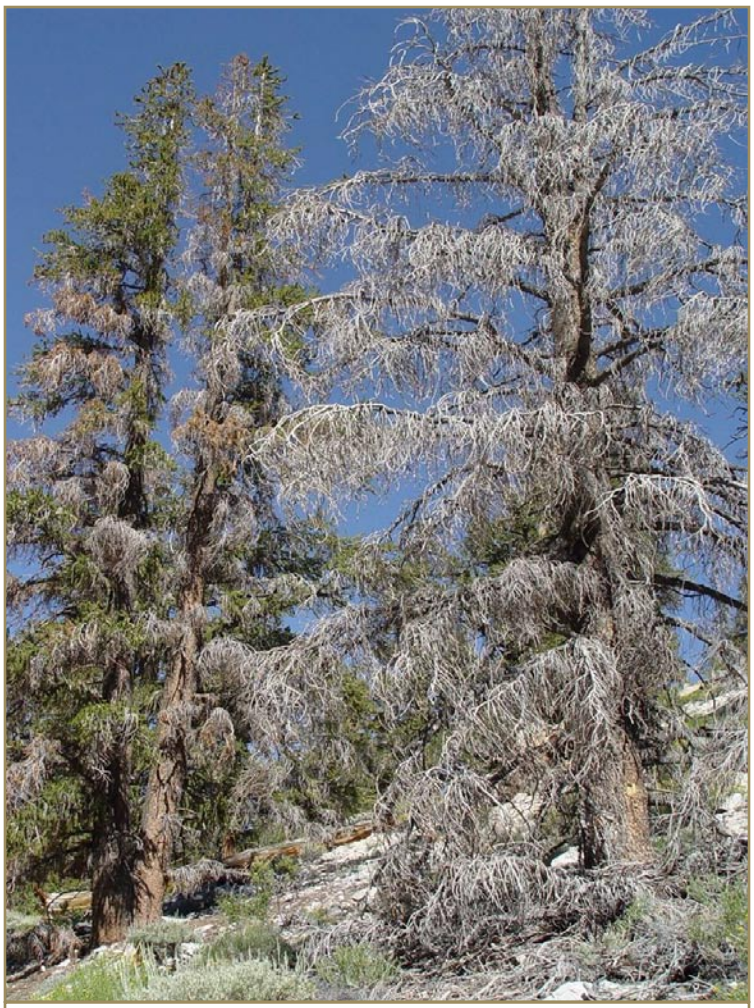
Annosus root disease continues to cause scattered pockets of mortality of ponderosa pine on McCloud Flats on the Shasta-Trinity National Forest. Mortality is impacting management in the Pilgrim Sale Area.

Annosus root disease on a white fir stump near Little Grass Valley Reservoir on the Plumas National Forest. Photo: William Woodruff

Annosus root disease was identified from laminated decay and the presence of fruiting bodies in scattered white fir stumps near Little Grass Valley Reservoir on the Plumas National Forest. Based on stunted growth and crown dieback, many young and old white fir trees in the area appear to be infected with root disease.

Because precipitation levels were again near normal in most of northwestern California during the winter of 2005-2006, ponderosa pine mortality due to a combination of drought, high stocking, **black stain root disease** and western pine beetle at McCloud Flats has decreased. However, conspicuous concentrations of mortality around black stain root disease centers were evident at the Mud Flow Research Natural Area, Elk Flat, Ash Creek Sink, Algoma and Harris Mountain; Shasta-Trinity National Forest.

A root disease with characteristics similar to *L. wageneri* was detected on bristlecone pines in the Ancient Bristlecone Pine Forest, Inyo National Forest. Identification of the pathogen is in progress. Black stain root disease has been killing pinyon pines at the lower elevations of the White Mountains for a number of years. Monitoring the extent and severity of the root disease in bristlecone pine will initiate in 2007.



Root disease with characteristics similar to *L. wageneri* on bristlecone pines in the Ancient Bristlecone Pine Forest, Inyo National Forest.

Over 22,000 traps were deployed and monitored as part of California's program to detect and delimit new **European gypsy moth (GM), Asian GM (AGM), or Siberian (SGM)** infestations in 2006. Seventeen moths were trapped at 11 sites in eight counties in 2006, compared to seven moths at seven sites in five counties during 2005. One AGM was captured near Long Beach, CA. The AGM detection was adjacent to a delimitation response area from a previous AGM find in San Pedro, CA in 2005.

Inspectors continued ground surveys for the **Asian longhorned beetle** (ALB) around the 2005 detection site in Sacramento County and the trace forward locations in Los Angeles and San Diego Counties. Over 16,000 trees were surveyed as of November, 2006, none of which showed any signs of ALB.

Five specimens of the exotic longhorned beetle ***Icosium tomentosum*** were recovered in Orange County in 2006. A visual survey within a 1/4 mile radius of the initial detection failed to detect any evidence of an established infestation.

The exotic longhorned beetle *Icosium tomentosum*; detected in Orange County in 2006. Photo: M. Hoskovec

Pitch canker disease increased within the Coastal Pitch Canker Zone of Infestation in California during 2006. It has not spread outside of the previously infected areas but has intensified within this zone. In areas where the infestation has existed for a long period of time, the disease has moved up higher in elevation.

Port-Orford-cedar root disease continues to spread and intensify along the known infested waterways. The disease was identified in Port-Orford-cedar and Pacific yew along Clear Creek in the Siskiyou Wilderness Area. This was the first identification of the exotic root disease in the Wilderness Area and on the Klamath National Forest. Fourteen years after Port-Orford-cedar root disease was eradicated from Cedar Rustic Camp, both the host tree and the disease organism have reinvaded due to a lack of maintenance. All infected and uninfected Port-Orford-cedar have since been removed from the campground. The Trinity River drainage continues to be the only major uninfested river drainage within the range of Port-Orford-cedar.

Injury from **white pine blister rust** continued to intensify on five-needle pine species throughout the known infestation zone. During 2006 the rust resistance program screened 799 sugar pine families from new candidate trees suspected of carrying major gene resistance (MGR) to blister rust; 49 families proved to be from MGR seed-parent trees. This brings the total number of proven resistant trees to 1,625 in the Pacific Southwest Region, including trees located on other federal, state and private lands within the State.

Port-Orford-cedar mortality due to Port-Orford-cedar root disease along Clear Creek in the Siskiyou Wilderness Area, Klamath National Forest. Photo: Dave Schultz

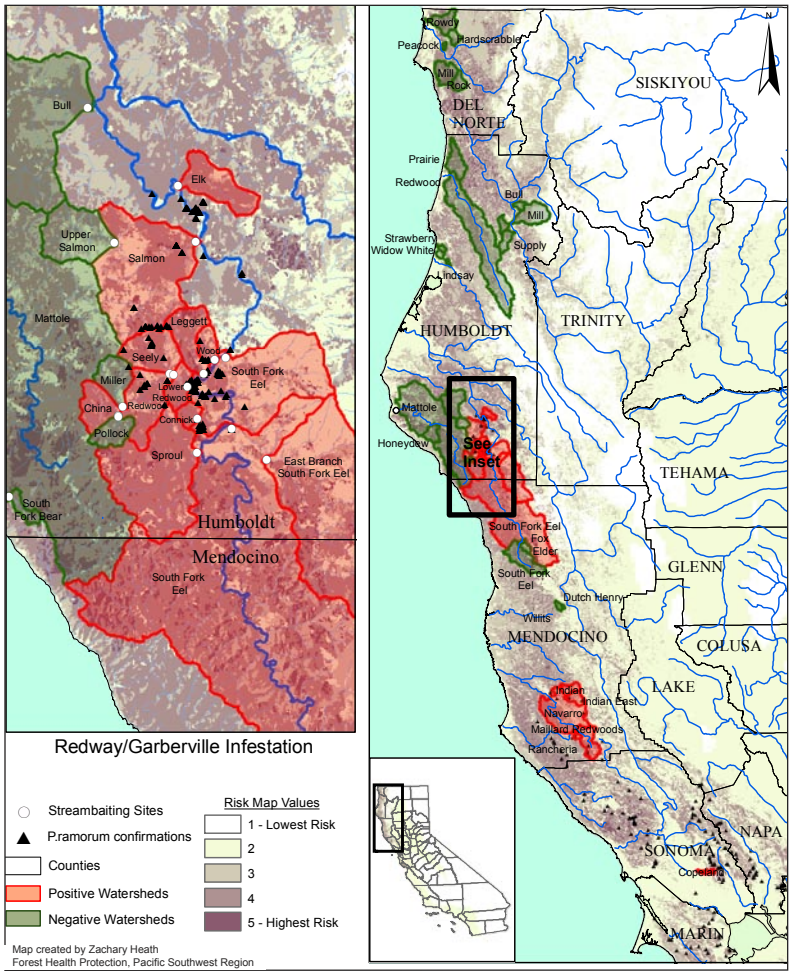
The distribution of **sudden oak death** in California did not change significantly (there were no new counties) but *Phytophthora ramorum*-related mortality in 2006 was at the highest level observed since 2000. Recent estimates suggest that more than a million overstory trees have been killed in California, with at least another million currently infected. The increased mortality is attributed to above average rainfall and late spring rains in 2005 and 2006, followed by an exceptionally hot summer in 2006.

New hosts. Twenty new hosts were confirmed and added to the USDA Animal and Plant Health Inspection Service. *ramorum* regulated list in 2006. While many of these new hosts were detected in nursery settings outside of the U.S., new additions of particular importance for California forests were *Abies magnifica* (red fir), *Ceanothus thyrsiflorus* (blueblossom), and *Eucalyptus haemastoma* Sm. (Myrtaceae – Myrtle family). The current list of hosts, including over 100 plant species in more than 60 genera, can be found on the COMTF website, www.suddenoakdeath.org.

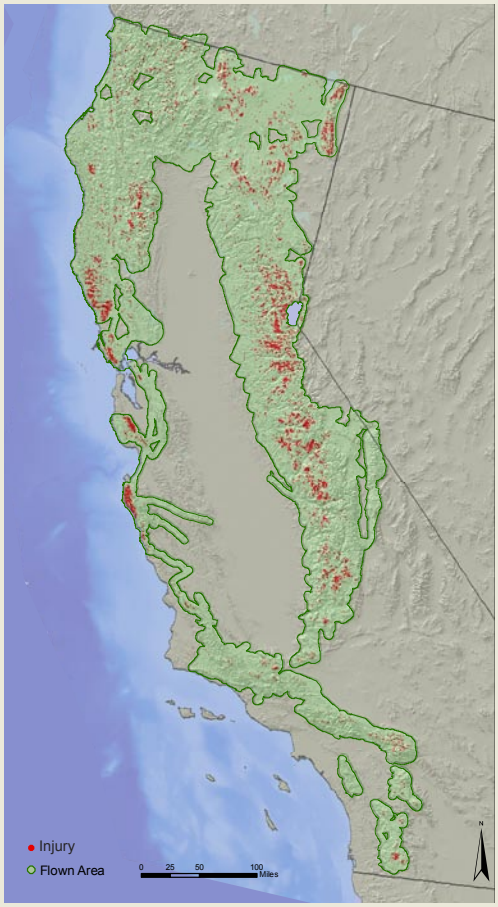
Surveys and monitoring. The USDA Forest Service (USFS) and Cal Poly San Luis Obispo completed their 2006 SOD aerial and targeted ground survey of high-risk forest areas, covering 6,667 miles and 9,000,000 acres in 11 counties. Approximately 20,000 acres of tanoak and oak mortality were mapped with nine new infestations detected in southern Mendocino County and one in Willow Creek, Monterey County. Watershed monitoring conducted by University of California, Davis (UCD) and University of California Cooperative Extension (UCCE) continued in streams outside of known infested areas, with no new finds made outside of the 14 quarantined counties (Maps 5 and 6). The California Department of Forestry and Fire Protection also conducted the California National *P. ramorum* Survey of Forest Environments in cooperation with the USFS, and found no new areas of infection.

As part of the 2006 National *Phytophthora ramorum* wildland survey, detection surveys were conducted in the Sierra Nevada foothills of Butte, Yuba, Nevada, Placer, and El Dorado Counties. Two types of surveys were conducted: 1) a road survey combined with vegetation transects to record hosts of *P. ramorum* and sample symptomatic host tissue, and 2) a stream survey that utilized Rhododendron leaves as bait for *Phytophthora* spp. in stream water. A total of 32 vegetation transects were surveyed and 23 streams were baited. Several hundred miles of roadside vegetation were scanned while driving through areas identified as being moderate to high risk for sudden oak death. Four vegetation samples were collected for lab diagnosis. *P. ramorum* was not detected by any of the survey methods. A commonly encountered Phytophthora, *P. gonapodyides* was recovered from seven streams.

Distribution of sudden oak death, December 20, 2006



2006 Watershed monitoring for *Phytophthora ramorum* in northern California (conducted by UCD and UCCE).



Area flown and injury detected in 2006.

The US Forest Service Forest Health Protection program conducts aerial detection surveys nationally. Surveys have been conducted in the Pacific Southwest Region annually since 1994. Data is collected using a digital aerial sketch mapping system following national protocols in order to provide standardized information on biotic and abiotic injury to California's forested ecosystems.

Highlights for 2006…

The area flown in California increased from approximately 28 million acres during 2005 to approximately 43 million acres in 2006 to include additional State, private, and other Federal lands .

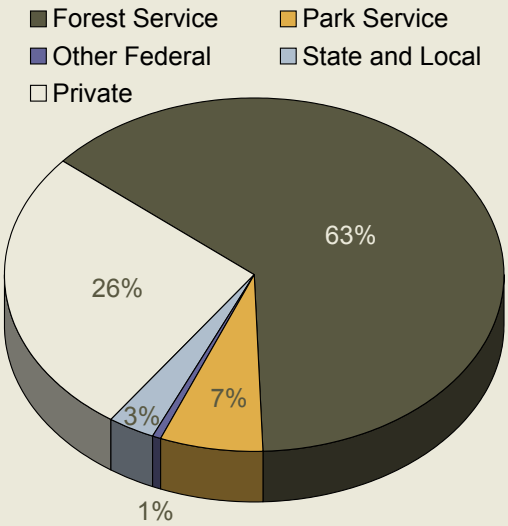
Approximately 727,000 acres with mortality were observed and mapped in California, including nearly 400,000 acres caused by biotic agents such as bark beetles and diseases.

High levels of mortality caused by black stain root disease, mountain pine beetle and western pine beetle continued to be observed in the northern portion of the state (Klamath, Modoc, and Shasta-Trinity National Forests).

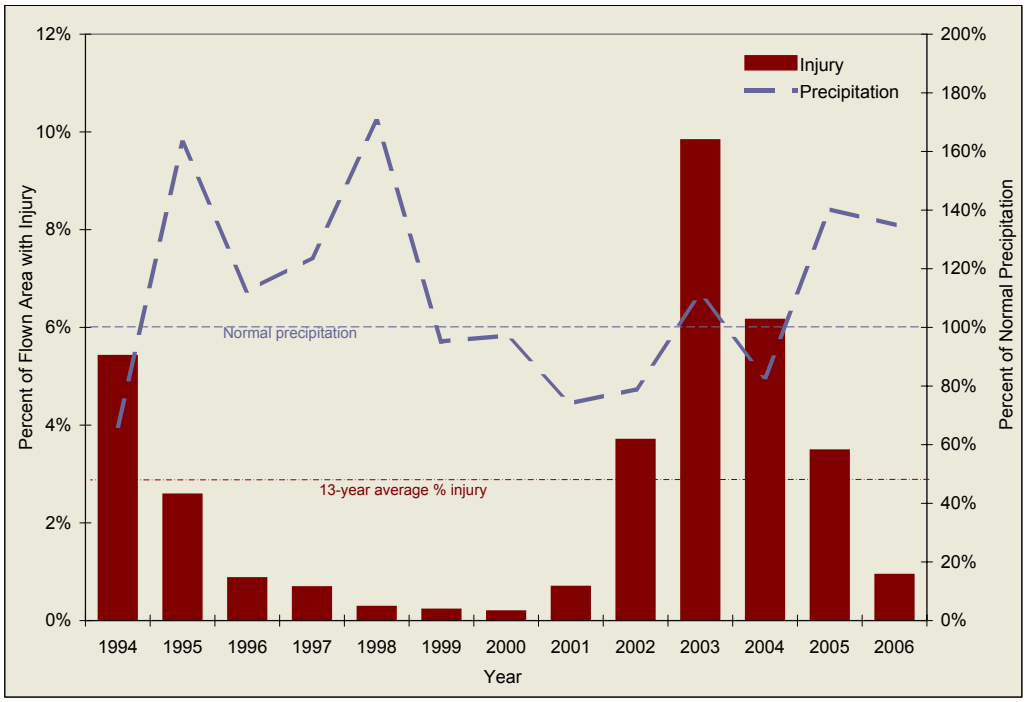
High levels of defoliation caused by the Douglas-fir tussock moth continued in many areas of California, increasing over the past year. Approximately 22,000 acres of defoliation were mapped (Sierra, Stanislaus, and the Shasta-Trinity National Forests and Yosemite National Park).

Hardwood mortality related to sudden oak death continues to advance within currently infested counties.

The 2006 Aerial Survey Report contains maps and tables summarizing acres of mortality and injury mapped by National Forest, National Park and County. To download the 2006 Aerial Survey Report, view standards, metadata, maps and data, visit: www.fs.fed.us/r5/spf/fhp.



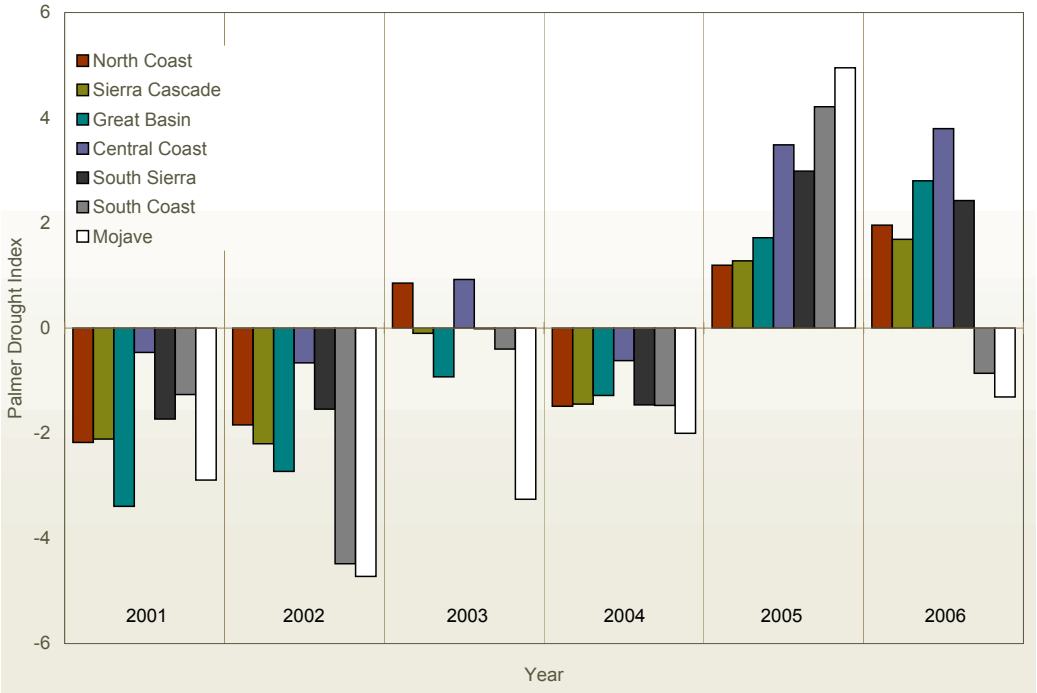
Percentage of acres detected with injury by ownership in 2006.



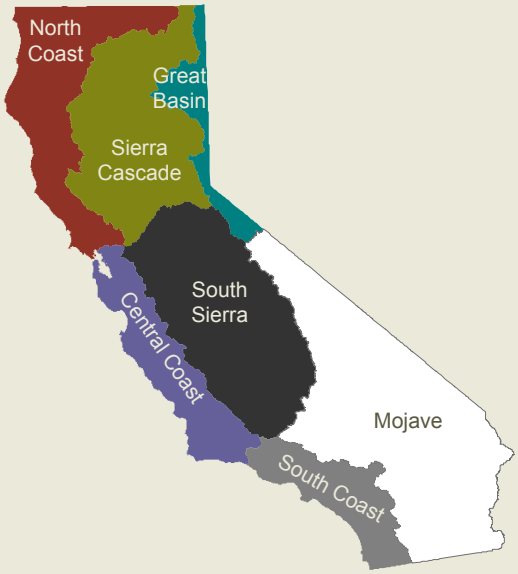
Statewide aerial survey results: Percent of flown area with injury and percent of normal precipitation; 1994-2006.

Precipitation and Drought

Information from two sources illustrates meteorological conditions in California over the past few years: the Palmer Drought Indices and data collected by the California Department of Water Resources. The Palmer Drought Index is an indicator of drought or moisture excess and ranges from -6 to +6, with the negative values denoting degree of drought. Wet conditions continued for most of California in 2006. The statewide average snowpack condition in April was 125% of normal. Overall precipitation for the state was at 135% of normal in 2006, however dry to slight drought conditions returned to the South Coast and Mojave regions.



Palmer drought indices for the seven hydrologic zones in California, 2001-2006.



Hydrologic zones in California.

Heat

Oak trees in the central Sierra Nevada foothills (Nevada, Placer, El Dorado, Shasta and Amador Counties and surrounding areas) have suffered from dieback due to the extreme extended heat that occurred in the month of July. Trees showed signs of branch dieback and early defoliation. No insect or biotic disease problems were noted.

The excessive heat wave in July may have been associated with the browning of chemise in Mendocino County. The heat may have led to the rapid death of stem-infected tanoaks across SOD regions, as *P. ramorum* may also be acting as a wilt pathogen in tanoak. Several consecutive days of temperatures over 115 degrees F, combined with windy conditions in the northern end of the Sacramento Valley caused a scorched appearance on many ornamental plants in Shasta County.

Wind

On the morning of December 31, 2005 strong winds swept across Humboldt, Del Norte and Western Trinity Counties. Wind speeds up to 97 mph were recorded around Humboldt Bay. The winds caused tree injury (2-3 foot diameter trees snapped) near Cape Mendocino to north of Trinidad and as far inland as Salyer with other minor injury reported further north.

Several consecutive days of temperatures over 115 degrees F, combined with windy conditions in the northern end of the Sacramento Valley caused a scorched appearance in many ornamental plants. Photo: Dave Schultz

P-3 Indicator Summary:

The USDA Forest Service's Forest Inventory and Analysis (FIA) uses biomonitoring to monitor the potential impact of tropospheric ozone (smog) on forests. Bioindicators are plants that exhibit a visible response to ozone pollution.

Seventy-two ozone biosites were visited in 2006 in California; ozone injury was present on 31 percent of them. Of the 22 positive sites, almost half were in the San Joaquin Valley and Mountain Counties air basins. There were three biosites where injury had not been detected previously (one each in the Mohave, NE Plateau, and Sacramento Valley air basins). Indicator species with validated injury were ponderosa pine, Jeffrey pine, and blue elderberry.

Additional analysis of ozone injury detected by the FIA program will be reported in the upcoming FIA 5-Year Report for California as well as a Pacific Northwest General Technical Report. The FIA ozone database (Access) for California, Oregon, and Washington for 2000-2005 is currently available from Sally Campbell, scampbell01@fs.fed.us.

Passive ozone samplers in southern California. Photo: Mike Arbaugh

Intensified Ozone Monitoring and Assessment of Ozone Impacts on Conifers in Southern California*

Michael Arbaugh, Andrzej Bytnerowicz, Pacific Southwest Research Station, and James Allison, Forest Health Protection

Intensified Ozone Monitoring in Southern California

Tropospheric ozone is a phytotoxic gaseous air pollutant formed by photolysis from air pollution generated by large metropolitan areas, during transport over long distances to rural areas. Ozone, together with drought and bark beetles, is one of the key stressors affecting forest trees adjacent to urban areas. Recently passive samplers have been used to measure ambient ozone concentrations. Passive samplers allow O_3 distribution to be characterized at forest stand and landscape scales. An extensive network of 37 passive ozone samplers were established in the southern California mountains, foothills and desert. Samplers were changed every 2-weeks between May and September 2005 and 2006. Several active ozone monitors were installed to provide calibration of passive samplers on-site. In addition, foliar injury was evaluated at 14 monitoring sites established during the 1960's and 1970's. Mortality was also measured at 14 long-term sites in the San Bernardino Mountains.

Mortality and Air Pollution in the San Bernardino Mountains

During the 1960's and 1970's a series of sites were established in the southern California Mountains by Paul Miller. Many of these sites have been lost, but 18 sites in the San Bernardino Mountains have been maintained. Mortality was assessed at 14 of these long-term study sites between 2005-2006. Preliminary results show a good correspondence between ambient ozone distribution (using 2006 data) and mortality levels. At several sites in western San Bernardino mountains all pines in study plots died during the drought of 2001-2004. In contrast, few pines died in low air pollution areas, despite these areas having less precipitation than high air pollution sites.

Foliar Injury and Ambient Ozone Distribution in Southern California Mountains

Foliar injury from ozone was evaluated at 14 sites in southern California mountains in 2006 using a Forest Health Protection protocol developed by John Pronos during the 1970's. This protocol is called the Forest Pest Management (FPM) protocol. Three branches from the lower 1/3 crown of each tree were evaluated using the specific criteria, then averaged to determine a single tree value.

The results indicate that foliar injury in Southern California is generally 'slight.' The most severe injury was observed in the western San Bernardino, San Jacinto, and Laguna Mountains. Equally and more severe injury was observed at long term sites in the Southern Sierra Nevada range using the same evaluation protocol. These results differ greatly from past work. In past studies, sites in the western San Bernardino Mountains had more severe injury than other sites in California. Many of the most severely impacted sites in the San Bernardino Mountains were not evaluated in 2006, because few or no pines remained at these sites.

**Poster presented at the 2007 FHM Working Group Meeting. January 31-February 3, 2007. San Diego, CA.*

Available on the Forest Health Monitoring Web Page.

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United States Department of Agriculture

Forest Service Pacific Southwest Region

California Department of Forestry and Fire Protection

California Forest Pest Council