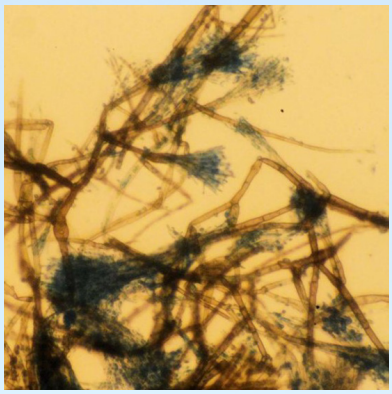

California Forest Pest Conditions 2022

A publication of the
California Forest Pest Council

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Cover photo:
Western pine beetle-caused mortality of ponderosa pine at Sugar Pine Reservoir (Placer County).
Photo Credit: D. Cluck, USDA Forest Service

Additional photos:
Left: Fruiting body of Onnia sp., most likely O. subtriquetra, on Monterey pine at the California Coastal National Monument near Point Arena (Mendocino County).Photo by: C. Lee, CAL FIRE

Center: Microscopic view of Leptographia heads, possible black stain root disease.
Photo by: M. MacKenzie, USDA Forest Service

Right: Amethyst cedar borer in incense-cedar, northern California. Photo by: C. Ewing, CAL FIRE

Survey Summary
Acres aerially surveyed 2022: 39.6 million acres
Acres aerially surveyed 2021: 38 million acres

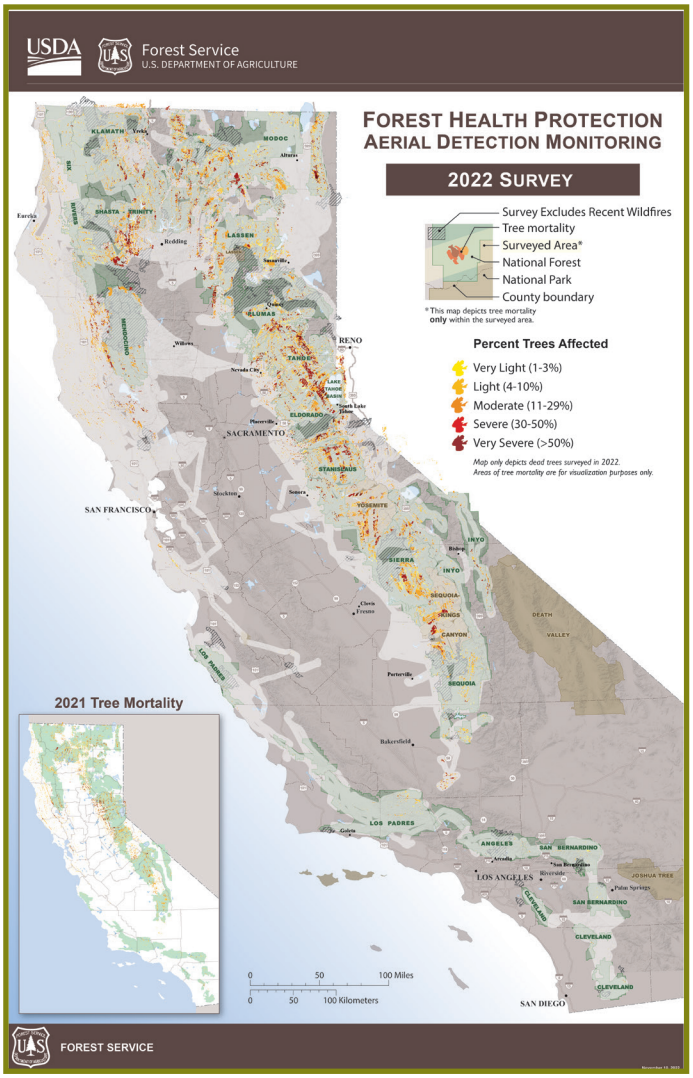
The USDA Forest Service (USFS), Pacific Southwest Region, State and Private Forestry staff conducts annual aerial detection surveys (ADS) throughout forested areas of California to detect tree mortality and tree damage such as defoliation or dead/dying branches. Surveys are flown in small, fixed-wing aircraft on a 4–5-mile grid pattern with two observers recording from opposite sides of the plane. Most National Forests (NF) and National Parks (NP) in California are surveyed, along with other federal, state, and private forested lands.

Approximately 39.6 million acres were surveyed during the 2022 flight season (July – October).

Several large areas were excluded from surveys in 2022 due to large wildfires that occurred within the previous three years. Insect and disease activity is difficult to discern in forests that have burned recently.

Elevated levels of tree mortality caused primarily by insects or diseases were recorded on approximately 2.6 million acres, totaling an estimated 36.3 million dead trees. The majority of trees killed were fir (*Abies* spp.), followed by ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*).

The following information was collected for each area with tree mortality or damage: a) damage type (mortality, top kill, defoliation, branch flagging, die back, or discoloration), b) percent of area affected (see below for severity scale), c) affected tree species or genus, and d) probable damage agent (root disease, bark beetles, etc.).



USDA Forest Service Aerial Detection Survey Results, California, 2022.
Map by: M. Woods, USDA Forest Service

Not all trees in reported acres are dead or damaged. Tree mortality and damage was recorded on a severity scale based on the percent of trees affected within a given area. Severity of mortality and damage was rated as follows: very light (1-3% of mapped area affected), light (4-10%), moderate (11-29%), severe (30-50%) and very severe (>50%). Below we report the estimated number of acres affected, the severity of mortality or damage within those acres, and estimated number of trees affected within those acres (rounded as appropriate).

Acres of mortality or damage may be noted in more than one bullet below as multiple damage agents can occur in the same location.

Bark Beetles and Wood Borers

- California/Shasta red fir (*Abies magnifica*), white fir (*Abies concolor*), bristlecone fir (*Abies bracteata*), and grand fir (*Abies grandis*) comprised over 77% of the tree mortality recorded in 2022. Approximately 28 million dead firs were recorded across ~1.9 million acres, compared to ~6.1 million dead firs across ~780,000 acres recorded in 2021. Mortality was most intense and widespread throughout the central Sierra Nevada Range.
  - White fir mortality was widespread but generally light to moderate in intensity and associated with heavily stocked mixed-conifer conditions.
  - Red fir mortality often occurred in mature, pure, high elevation stands at generally higher intensities.
- Pine mortality attributed to western pine beetle (*Dendroctonus brevicomis*) increased from an estimated 2.1 million dead trees across 300,000 acres in 2021 to ~3.5 million dead trees across 280,000 acres in 2022. Mortality was more common in northern areas of the State.

- Pine mortality attributed to mountain pine beetle (*Dendroctonus ponderosae*) remained elevated with an estimated ~380,000 dead trees across 44,000 acres in 2021 compared to ~390,000 dead trees across 40,000 acres in 2022 and was most prevalent in and around Mammoth on the Inyo NF.
- High elevation 5-needle pine (i.e. limber (*P. flexilis*), whitebark (*P. albicaulis*), western white (*P. monticola*), and foxtail (*P. balfouriana*)) mortality remained elevated with an estimated ~280,000 dead trees across 32,000 acres recorded in 2021 compared to ~310,000 dead trees across 26,000 acres in 2022. Mortality was particularly severe and widespread in areas south of Mammoth on the Inyo NF.
- Jeffrey pine (*Pinus jeffreyi*) mortality caused by Jeffrey pine beetle (*Dendroctonus jeffreyi*) or ips beetles (*Ips* spp.) increased from ~130,000 dead trees across 31,000 acres in 2021 compared to ~350,000 dead trees across 52,000 acres in 2022.
- Goldspotted oak borer (*Agrilus auroguttatus*)-related oak mortality, mostly in San Diego County, decreased from ~19,000 dead trees recorded across 4,000 acres in 2021 to ~8,000 dead trees across 1,600 acres in 2022. Areas on the Palomar Ranger District and Lake Henshaw continued to account for most of the total tree mortality recorded in 2022.
- Douglas-fir (*Psuedotsuga menziesii*) mortality (not attributed to damage by bears in pole-sized plantations) increased from ~170,000 dead trees across 18,000 acres in 2021 to an estimated 3 million dead trees across 190,000 acres in 2022. Mortality was particularly severe and widespread in areas around Redding.
- Pinyon pine (*Pinus monophylla*) mortality likely caused by Ips sp. increased from an estimated 60,000 dead trees across 10,000 acres in 2021 to ~220,000 dead trees across 16,000 acres in 2022 and occurred throughout its range in CA.

Ongoing severe whitebark pine mortality near Eagle Peak, Modoc County. Photo by: N. Stevens, USDA Forest Service

Ongoing and increasingly severe fir mortality near Mt. Silliman, Tulare County. Photo by: N. Stevens, USDA Forest Service

Ongoing mixed-conifer mortality along the Pit River tributary east of Shasta Lake, Shasta County. Ground observations indicate most of the mortality is Douglas-fir. Photo by: J. Moore, USDA Forest Service

Defoliation

- Severe defoliation of lodgepole pine (*Pinus contorta*) by lodgepole pine needleminer (*Coleotechnites milleri*) decreased from affecting ~8,500 acres in 2021 to 380 acres in 2022. Defoliation was concentrated in and around Yosemite NP.
- Severe defoliation of white fir (*Abies concolor*) by Douglas-fir tussock moth (*Orgyia pseudotsugata*) was detected on approximately 800 acres located southwest of Quincy on the Plumas NF.

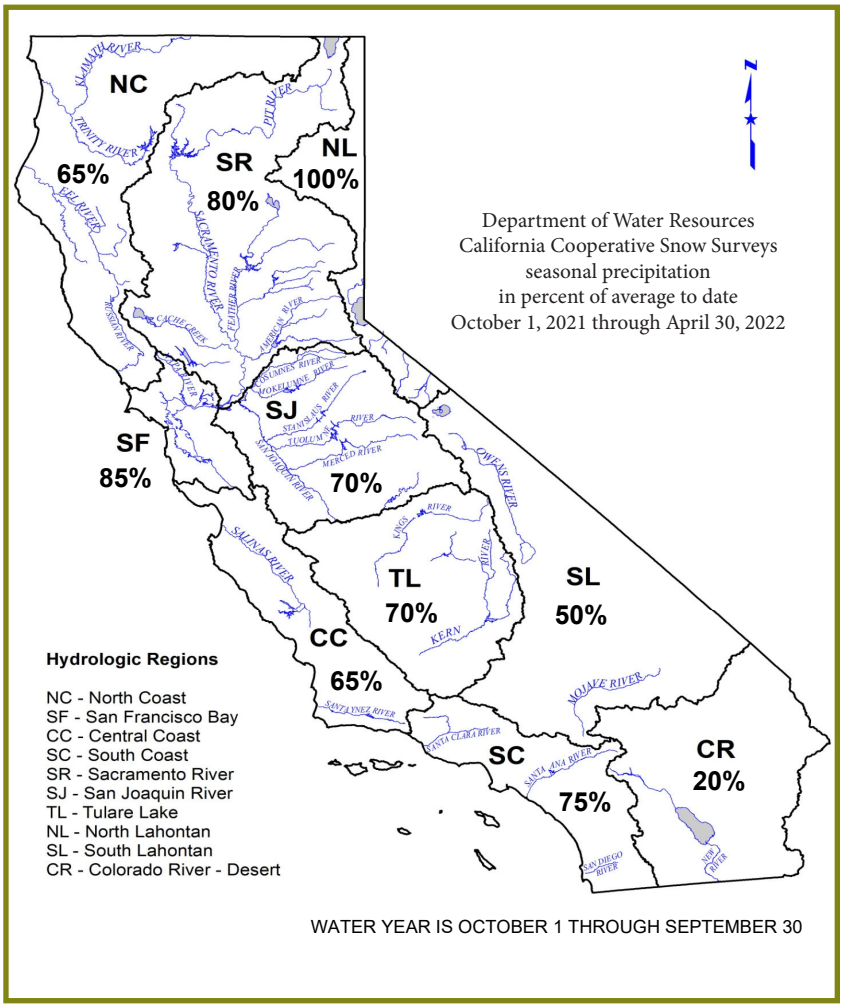
Diseases

- Tanoak (*Notholithocarpus densiflorus*) mortality attributed to sudden oak death (*Phytophthora ramorum*) continued to decrease from ~97,000 dead trees across 16,000 acres in 2021 to an estimated 36,000 dead oak trees across 7,300 acres in 2022. Several consecutive years of dry spring weather have inhibited the spread of this disease.

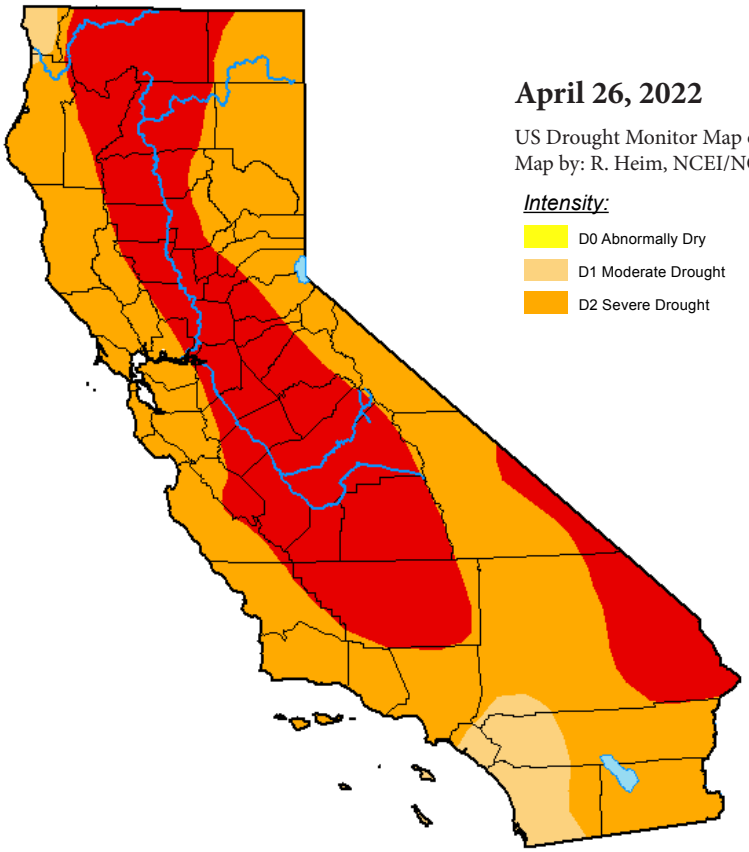
Drought

- Oak discoloration, early leaf-drop, and possible dieback and mortality were common throughout interior areas of the state. Mortality is difficult to distinguish from discoloration and dieback from a distance.
- Gray pine (*Pinus sabiniana*) mortality remained elevated but decreased from an estimated 53,000 dead trees across 4,200 acres in 2021 to ~2,300 dead trees across 250 acres in 2022.

Statewide precipitation in percent of average to date from October 2021 - April 2022 was 70%, compared to 50% for the same time period in 2020 - 2021. Northern California forested area rainfall totals were 65 - 100% of average, and Southern California areas were 20 - 75% of average (see map on right). The 2021 – 2022 water year (water year is from October 1 – September 30) was the 23rd driest on record (since January 1895). Precipitation was above average in October (4th wettest on record), December, August, and September, while January and February were the 2nd driest ever recorded (3.8" and 3.61" below average, respectively). Several other months were dryer than normal, but not record setting. 2022 water conditions as well as cumulative water conditions from previous years contributed to significant water deficits across the state (see map below).



Statewide temperatures varied widely from historical averages (1895 – 2022). While October and December temperatures were normal or cooler than average, every other month was warmer than normal, and November, August, and September were the 2nd warmest on record (5.3°F, 4.6°F, and 5.1°F above their monthly averages, respectively). The three-month period of July through September was the hottest on record, 4.2° above normal. The 2021 water year was the 5th warmest on record; the average annual temperature across California was 3.0°F above the historical average (https://www.ncdc.noaa.gov/cag/statewide/rankings).

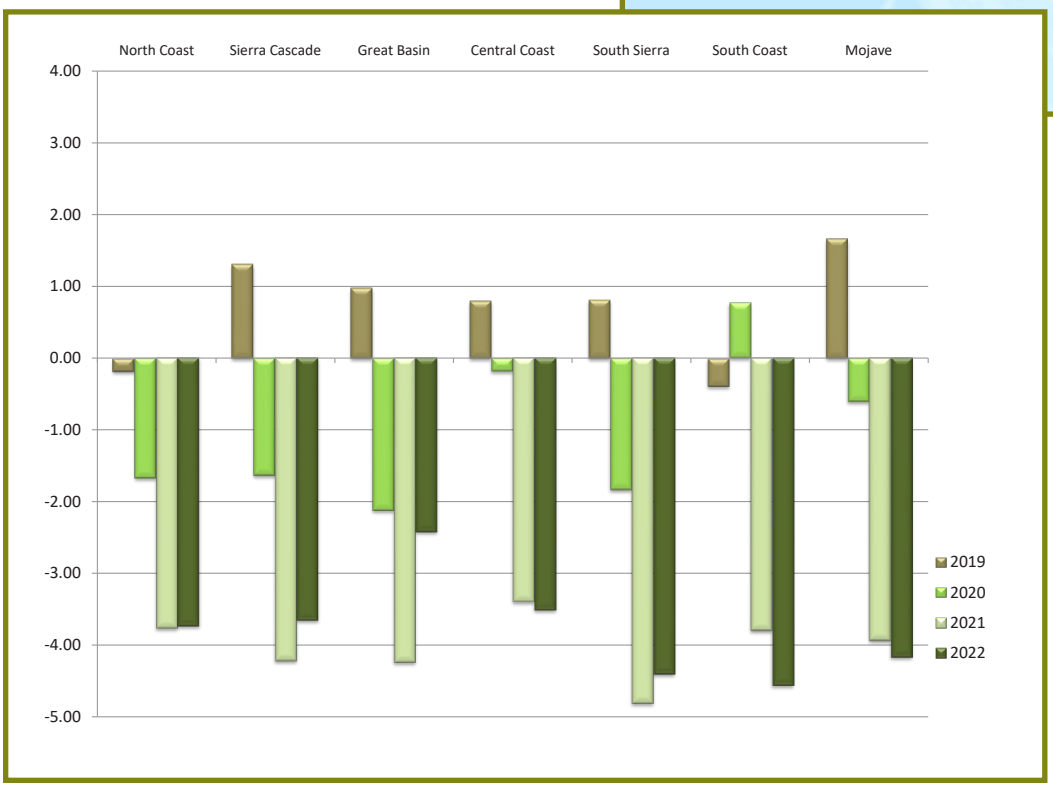


Palmer Drought Index

The Palmer Drought Severity Index (PDSI) is an indicator of drought and moisture excess, with negative values denoting degree of drought. For the 2021 – 2022 water year, the yearly average PDSI values ranged from -2.42 in the Great Basin (least dry zone) to -4.55 in the South Coast (driest zone) (see map). The majority of the state of California was in severe to exceptional drought conditions through Sept. 30, 2022.

Climate Divisions for the Palmer Drought Severity Index. Map by: M. Woods, USFS

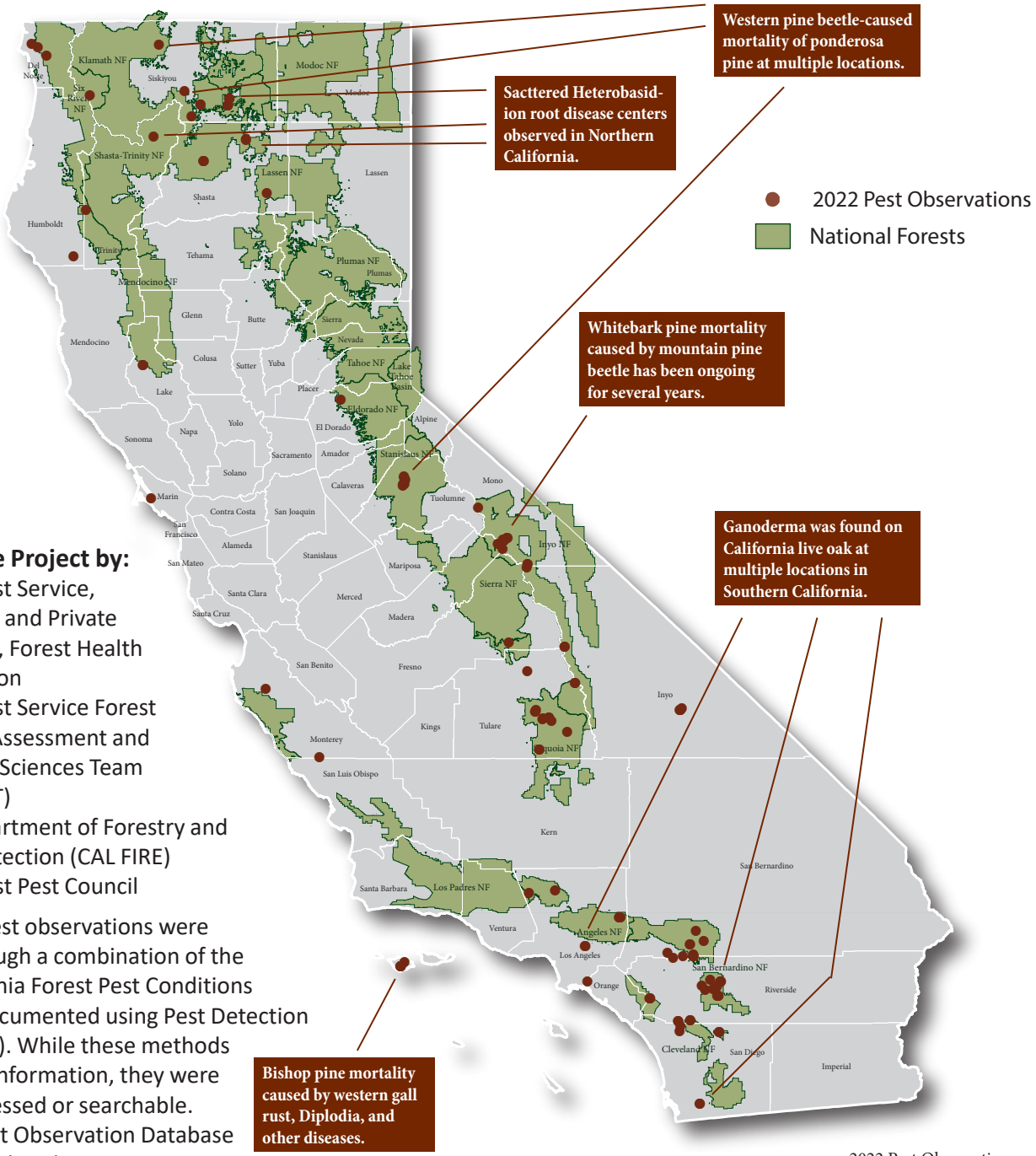
Palmer Drought Severity Index (PDSI) for California, 2019 - 2022



Source: National Climatic Data Center, U.S. Department of Commerce, https://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp

Palmer Classifications

4.0 or more	extremely wet
3.0 to 3.99	very wet
2.0 to 2.99	moderately wet
1.0 to 1.99	slightly wet
0.5 to 0.99	incipient wet spell
0.49 to -0.49	near normal
-0.5 to -0.99	incipient dry spell
-1.0 to -1.99	mild drought
-2.0 to -2.99	moderate drought
-3.0 to -3.99	severe drought
-4.0 or less	extreme drought



2022 Pest Observations.
Map by: M. Woods, USFS

Collaborative Project by:

- US Forest Service, R5 State and Private Forestry, Forest Health Protection
- US Forest Service Forest Health Assessment and Applied Sciences Team (FHAAST)
- CA Department of Forestry and Fire Protection (CAL FIRE)
- CA Forest Pest Council

Historically, pest observations were captured through a combination of the annual California Forest Pest Conditions Report and documented using Pest Detection Reports (PDRs). While these methods captured the information, they were not easily accessed or searchable. The Forest Pest Observation Database (FPODA) served as the primary repository for all forest pest observations in California between 2014 and 2018 but was retired in 2019.

A mobile pest detection data entry form was developed and released in 2018 and has been adopted across the Forest Health Protection Service Areas. Ground-based observations are located in a database on ArcGIS Online (AGOL).

For 2022, all observations were submitted via the mobile data entry form and supplement the Aerial Detection Survey data. This map shows the locations of pest observations made by forest health professionals in 2022. The most frequently reported damage-causing agent was western pine beetle, followed by mountain pine beetle, Heterobasidion root disease, and Ganoderma. The most frequently reported host species was ponderosa pine, followed by Jeffrey pine, California live oak, and white fir.

Native Insects

Bark Beetles

Mountain Pine Beetle (*Dendroctonus ponderosae*)

Mountain pine beetle-caused mortality of lodgepole pine (*Pinus contorta*) increased at Medicine Lake (Siskiyou County), with many groups of 3-20 trees killed over 2,000 acres. Pines in recreation areas and private cabins around the lake were at high risk of infestation. Verbenone was applied to protect campground trees.

Tree mortality also increased in the north Warner Mountains where mountain pine beetle killed hundreds of whitebark pine (*Pinus albicaulis*) as well as scattered western white pines (*Pinus monticola*). Higher levels of tree mortality were also reported near Mt. Vida and Bald Mountain (Modoc County).

An infestation of mountain pine beetle continued to linger in limber (*Pinus flexilis*) and single leaf pinyon (*Pinus monophylla*) pines surrounding Telescope Peak in Death Valley NP (Inyo County), but killed fewer trees than the five previous years. New mountain pine beetle infestations occurred near previously attacked and killed groups of limber and pinyon pine on the west side of Roger's Peak (Inyo County). No mountain pine beetle attacks were found on Great Basin bristlecones (*Pinus longaeva*) along Telescope Peak trail, however two bristlecone trees were attacked by other insects.

Mountain pine beetle continued to kill five-needle and lodgepole pines on west slopes of the eastern Sierra Nevada. Scattered, small groups of infested trees were observed in areas where activity has been ongoing for several years. Most beetle activity appeared to be moving outward from older infestation centers and affecting the remaining green trees.

Mountain pine beetle-caused tree mortality around Mammoth Mountain (Mono County) has shifted to higher elevations, from lodgepole pine forests to whitebark pine. Within the last five years, mountain pine beetle has killed lodgepole and western white pines on the lower slopes near Mammoth Lakes Basin (Mono County). This year, five clusters of mature whitebark pine around Minaret Vista (Mono County) were infested by mountain pine beetle and, occasionally, ips (*Ips* spp.) beetles.

At Rock Creek Recreation Area (Mammoth Lakes Ranger District, Inyo NF, Mono County) whitebark and lodgepole pines were killed by mountain pine beetle from 2009-2012, and mature trees that survived that event are being attacked again this year. Ground surveys confirmed new mountain pine beetle infestations in three separate areas reported from 2022 Aerial Detection Surveys.

At Saddlebag Lake, in areas where lodgepole and whitebark pine occur together, mountain pine beetle attacks were reported on ten whitebark pines in three separate groups (Mono County). Where these lodgepole and whitebark pine co-occur, mountain pine beetle prefers to attack and kill mature whitebark pine first, moving to lodgepole pine once infestations have progressed and beetle pressure is high.

A Sequoia-Kings Canyon NP high-elevation monitoring crew observed a few mountain pine beetle-killed mature foxtail pines (*Pinus balfouriana*) in their wilderness monitoring plots this summer. Mountain pine beetle successfully reproduced and emerged from these trees but did not appear to move into neighboring host trees (Tulare County). Mountain pine beetle also attacked a few windfallen trees in the Golden Trout Wilderness near Chicken Spring Lake (Inyo County).

Western Pine Beetle

(*Dendroctonus brevicomis*)

There was increased western pine beetle activity leading to large patches of ponderosa pine (*Pinus ponderosa*) mortality in parts of Nevada and Sierra Counties. Mountain pine beetle attacks were often accompanied by ips or red turpentine beetle (*Dendroctonus valens*) infestations.

Ponderosa pine mortality attributed to western pine beetle increased significantly in northwestern California (Lake, Mendocino, Sonoma, Napa, Shasta, Trinity, and Siskiyou Counties). Several groups of 10-30 ponderosa pine were killed along the shoreline of Shasta Lake, Shasta-Trinity NF (Shasta County). The mortality began to intensify in 2021

Western pine beetle-caused ponderosa pine mortality increased significantly across northwestern California. Photo by: C. Lee, CAL FIRE

Western pine beetle-caused mortality of ponderosa pine at Sugar Pine Reservoir (Placer County).
Photo by: D. Cluck, USDA Forest Service

Western pine beetle-caused mortality of ponderosa pine, Stanislaus NF (Tuolumne County).
Photo by: B. Bulaon, USDA Forest Service

and increased greatly in the first half of 2022. The increase in dead crowns early in the year may indicate that insects were active during the winter months. The landscape-level ponderosa pine mortality was greatest at low elevation (<4,000 ft) dry sites, sites also occupied or formerly occupied by oak species, and along southern and western aspects. In some areas with shallow water tables or excessively drained soils, mortality was seen on other aspects.

From the headwaters of Mt. Savage to Wawona Campground (Yosemite NP, Mariposa County), significant ponderosa pine mortality caused by western pine beetle was visible along Highway 41. Groups of dead trees lined the upper hillside and the north face of Mt. Savage as it connects to Big Creek. Groups were comprised of 5-10 ponderosa pine and appeared to have been attacked the previous year due to the complete red color of needles. Woodpecker flecking was seen in the upper bole of infested trees.

Woodpecker foraging on western pine beetle-attacked ponderosa pine, Stanislaus NF (Tuolumne County).
Photo by: B. Bulaon, USDA Forest Service

Older ponderosa pine plantations continued to be susceptible to western pine beetle infestation in the Sierra Nevada Range. On the Eldorado NF, western pine beetle populations in the Cleveland plantation (El Dorado County) that were building for a few years caused about five acres of mortality in 2021, affecting roughly 100 trees with an average diameter of 15 inches. In 2022, new mortality was observed in several >20 inch-diameter trees at the edges of the area impacted in 2021. Further north, western pine beetle activity was observed along Foresthill Divide Road and Sugar Pine Reservoir, northeast of Foresthill (Placer County). Mortality consisted of multiple groups of 5-100 dead trees over several thousand acres of old ponderosa pine plantations (>50 year old trees).

A prescribed fire on Mount Provo (Mi-Wok Ranger District, Stanislaus NF, Tuolumne County) was conducted in December 2021, and deemed a low-intensity burn. Forest Health Protection (FHP) staff examined the burned area in February 2022 since an undesirable number of tree crowns were turning color within the burn perimeter. FHP staff found western pine beetle and pine engraver (*Ips* spp.) attacks that occurred before the fire. Only two newly-attacked ponderosa pines were found in the burn perimeter, while all others were outside the burn area (on the other side of the road which was used as the fire boundary). Infested trees were easy to identify: fade started from the top, and moved downward with heavy bark flecking on the bole from woodpecker foraging. A total of ten trees, averaging 15 inches in diameter, were observed with old beetle galleries and exit holes indicating beetles had reproduced and the new generation already left.

Jeffrey Pine Beetle (*Dendroctonus jeffreyi*)
Jeffrey pine beetle populations increased in 2022 as previous activity areas expanded in size and new activity centers appeared nearby or in forested areas that were untouched until this past summer. Jeffrey pine beetle-associated Jeffrey pine (*Pinus jeffreyi*) mortality continued to surge in the valley around Inyo Craters Recreation Area (Mammoth Lakes Ranger District, Inyo NF, Mono County). New areas of beetle activity appeared in scattered spots consisting of 30 or more trees. Jeffrey pine beetle killed most of the Jeffrey pine on the southern side of the Inyo Craters Trailhead parking lot (Road 3S89). Lodgepole pine and red fir in this valley are also significantly impacted by other bark beetle species. Across the valley and Highway 395, multiple groups of 3-5 Jeffrey pines were killed in Antelope Spring and around Lookout Mountain.

Further south, along roads leading up to Horseshoe Meadows from Lone Pine, or Onion Valley outside of Independence (Inyo County), scattered mature (>25 inch in diameter) Jeffrey pines on harsh slopes and rocky terrain were killed by Jeffrey pine beetles or ips.

Jeffrey pine beetle caused significant mortality of Jeffrey pines at the Inyo Craters Trailhead, Inyo NF (Mono County). Photo by: B. Bulaon, USDA Forest Service

Douglas-fir Beetle (*Dendroctonus pseudotsugae*)
A new outbreak of Douglas-fir beetle was detected in Jackson Demonstration State Forest (Mendocino County). The outbreak covered 1-3 acres and was in the northwestern part of the Forest, not far from Highway 20. This outbreak was likely initiated by the abrupt cessation of timber harvest operations in the area, resulting in large Douglas-fir (*Pseudotsuga menziesii*) logs being left on the forest floor. These logs served as brood material from which new beetles attacked standing green mature trees. The ambrosia beetle (*Gnathotrichus sulcatus*) and Douglas-fir beetle simultaneously attacked both dead/dying material and living green trees. The mature Douglas-fir trees were likely predisposed to stress and beetle attack by the extensive presence of the root- and butt-rotting fungus, *Phaeolus schweinitzii*, in the stand.

Red Turpentine Beetle (*Dendroctonus valens*)
Red turpentine beetle pitch tubes were observed on scattered dying Monterey pines (*Pinus radiata*) (~10 acre area) near Briones Reservoir (Contra Costa County). They were also observed on scattered dying ponderosa pines near Felton (Santa Cruz County) (see “Stain Fungi” in the Disease section).

Fir Engraver (*Scolytus ventralis*)
Extensive white (*Abies concolor*) and red fir (*Abies magnifica*) mortality caused by drought and fir engraver was captured by USDA Forest Health Monitoring Aerial Detection Survey flights, a level of mortality not seen since the 1990s. Many trees were killed while others had dead crowns (top-dieback).

Large areas of white fir mortality occurred between Truckee and Donner Summit on the north side of Interstate 80 (Nevada County) and at the south end of Sierra Valley out of Sierraville (Sierra County). True fir mortality increased in high elevation mixed-conifer forests on the Shasta-Trinity NF (Siskiyou County). Mortality was most associated with fir engraver beetle attacks in ridgeline stands affected by the last 2-3 years of drought conditions.

While both white and red firs were killed throughout the central and southern Sierra Nevada Range, red fir at higher elevations appeared more heavily impacted. Red fir mortality was particularly severe in the following locations: Deadman Creek

Red and white fir mortality caused by fir engraver beetle near Deadman Creek, Stanislaus NF (Tuolumne County). Photo by: B. Bulaon, USDA Forest Service

south of Sonora Pass (Stanislaus NF, Tuolumne County), Mammoth Mountain and hillsides around Mammoth Lakes and into Inyo Crater Valley (Inyo NF, Mono County), and Mattley Ridge (Calaveras County). Mortality was observed in both previously treated stands and untreated stands, but fewer trees died in the treated stands.

Red and white fir mortality caused by fir engraver beetle near Mattley Ridge (Calaveras County). Photo by: B. Bulaon, USDA Forest Service

Knobcone mortality caused by *Ips* at Mt. Konocti (Lake County). Photo by: C. Lee, CAL FIRE.

Pine Engravers (*Ips* spp.)

Ips infestations were observed intermixed with other damage agents on uncommon hosts this summer in eastside Sierra Nevada forests. For example, Ips were found infesting a lone bristlecone pine on Telescope Peak despite recent widespread mountain pine beetle-caused mortality of Great Basin bristlecone pine in the area. They were also found in whitebark pine stems that were concurrently attacked by mountain pine beetle at Saddlebag Lake Campground and Minaret Summit (Inyo NF, Mono County).

Pine engraver (*Ips pini*)-caused top-kill of Jeffrey and ponderosa pine was widespread along the eastern edge of Modoc, Lassen, and Plumas NFs. Specific areas of elevated activity were Highway 139 south of Adin (Lassen County), Susanville, Janesville, and Milford areas along Highway 395 (Lassen County), and groups at the northwest edge of Sierra Valley near Beckwourth (Plumas County). All areas consisted of multiple groups of 3-40 top-killed trees.

California five-spined ips (*Ips paraconfusus*) caused extensive stand-level mortality of knobcone pine (*Pinus attenuata*) in many locations throughout northwestern California in 2022. Notable areas of stand-level mortality included Mt. Diablo (Contra Costa County) and Mt. Konocti (Lake County). California five-spined ips caused stand-level mortality of Monterey pine near San Pablo Reservoir and Briones Reservoir (Contra Costa County). Monterey pine damage is more commonly associated with Monterey pine ips (*Pseudips mexicanus*). Monterey pine ips was also observed breeding in bishop pine (*Pinus muricata*) slash created by utility line clearance activities near Trinidad in Humboldt County, along with the minor bark beetle *Hylurgops porosus*.

Pine engraver-caused mortality has been observed for several years at Torrey Pines State Natural Reserve, a 2,000 acre reserve located along the coast in San Diego County. A combination of drought, higher than average temperatures, and California five-spined ips attacks have killed 12% of the adult Torrey pines (*Pinus torreyana*) between 2006-2018. Efforts are underway to increase Torrey pine recruitment and potentially protect existing trees using repellents. Ips populations continue to be monitored at this site. Torrey pines are endemic to San Diego County and listed as Critically Endangered by the International Union for Conservation of Nature (IUCN).

While mountain pine beetle was found on pinyons at elevations of 7,000 feet and higher around Telescope Peak (Death Valley NP, Mono County), lower elevation pinyons were heavily infested with pinyon ips. Mortality at these lower elevations was scattered and found in variable sized trees along Mahogany Road leading to Thorndike Campground (Inyo County). Pinyon trees in the lowest flat valleys were also moderately to severely infested with dwarf mistletoe which are likely contributing to rapid tree decline.

Flatheaded Fir Borer (*Phaenops drummondi*)

In 2022, Douglas-fir mortality attributed to flatheaded fir borer (and drought) followed a similar trend as ponderosa pine mortality throughout much of northern California but over a wider range of counties (Alameda, Contra Costa, Del Norte, Humboldt, Lake,

Douglas-fir mortality caused by flatheaded fir borer. Photo by: C. Lee, CAL FIRE

Flatheaded fir borer pupae.
Photo by: C. Lee, CAL FIRE

Douglas-fir mortality caused by flatheaded fir borer near Deer Creek (Butte County).
Photo by: D. Cluck, USDA Forest Service

Douglas-fir mortality caused by flatheaded fir borer near Lake Britton (Shasta County). Photo by: D. Cluck, USDA Forest Service

Marin, Mendocino, Napa, San Francisco, San Mateo, Santa Clara, Santa Cruz, Shasta, Siskiyou, Sonoma, and Trinity Counties). In Shasta, Lassen, Trinity, and Siskiyou Counties, flatheaded borers are the primary insects attacking stressed trees. Douglas-fir mortality was observed at several low elevation sites along Highway 299 which crosses Shasta-Trinity NF (Trinity and Shasta Counties) including adjacent private lands between Weaverville and Round Mountain. Most tree mortality occurred in larger trees (>20 inch diameter) scattered across several thousand acres. In the Pit River drainage below Lake Britton (Shasta County) and Deer Creek drainage at the western boundary of Lassen NF (Butte County), scattered mortality of 10-30 inch diameter trees occurred over 200 acres. Douglas-fir in Lake and Napa Counties were heavily infested by flatheaded fir borer but were also attacked by *Scolytus* sp. and *Pseudohylisinus* sp.

Detection of recent Douglas-fir tree mortality was difficult in some areas because Douglas-fir can shed red needles rapidly, leaving bare, gray crowns that resemble older mortality. In other areas, Douglas-fir mortality was difficult to detect because individual dead trees were scattered across the landscape. Douglas-fir mortality was most likely to occur in areas where the species encroached on oak woodlands or occupied western or southern aspects. In previous years, sporadic and sparse Douglas-fir mortality occurred, resulting in a slow accumulation of dead trees. In 2022, many sites had complete or nearly complete Douglas-fir mortality.

Flatheaded fir borer populations increased in several locations throughout the southern Sierra Nevada Range where Douglas-fir trees reside on drier aspects and oak-dominated low elevation areas. Surrounding the Chili Bar Reservoir (El Dorado County),

Douglas-fir mortality caused by flatheaded fir borer, East Bay.
Photo by: C. Lee, CAL FIRE

Douglas-fir mortality caused by flatheaded fir borer near the Chili Bar Reservoir (El Dorado County). Photo by: B. Bulaon, USDA Forest Service

Flatheaded fir borer larvae on Douglas-fir.
Photo by: C. Ewing, CAL FIRE

Douglas-fir mortality caused by flatheaded fir borer near Beardsley Lake, Stanislaus NF.
Photo by: B. Bulaon, USDA Forest Service

Douglas-fir line the steep slopes of Big Canyon and Kelsey Canyon, flowing into the south fork of the American River. Mortality ranged from moderate to severe (5-10 trees per acre) within this basin, with all sizes of Douglas-fir in slow decline. Slightly north in Kelsey, Douglas-fir along ridgetops and roads died in similar numbers. In Tuolumne County, along road 1N04 east of River Ranch Campground, Douglas-fir mortality was observed along south-facing slopes around Murphy Peak (Stanislaus NF). Widespread Douglas-fir die-off also occurred along a southern slope facing Beardsley Lake. Two >40 inch diameter Douglas-fir were examined and mortality was confirmed to be caused by fir borer.

Flatheaded fir borer was also the primary mortality-agent of white fir near Deer Mountain (Siskiyou County). Fir borers were active in the lower 75-80% of white fir trunks, while fir engravers colonized the top 20-25% of the tree. Since 2018, this pattern has been observed in Douglas-fir in many areas of California (including Siskiyou County), but it had not been observed in white fir. In 2018, fir engravers attacked white fir from the root collar to the top of tree. Flatheaded fir borer was a secondary pest at that time, only attacking cambium previously damaged by fir engraver.

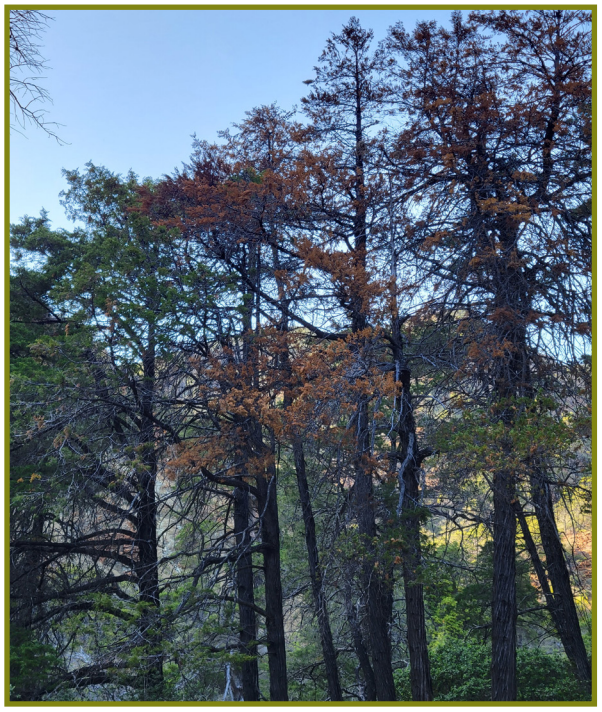
Redwood, Cypress, and Cedar Bark Beetles (*Phloeosinus sp.*)

Redwood bark beetles (*Phloeosinus sequoiae*) are typically seen colonizing coast redwood material or slash. In 2022 redwood bark beetle activity was observed in Jackson Demonstration State Forest near Highway 20 (Mendocino County) where abrupt cessation of timber harvest activity left many full-sized redwood logs on the ground. Redwood bark beetle infestation, indicated by boring dust, was observed on at least one standing green redwood tree. The beetles also colonized large-diameter redwood branches that fell to the ground in Pamplin Grove and Van Duzen County Park in Humboldt County during the summer (see "Redwood Branch Fall" in Abiotic Injuries). In Santa Cruz County, understory redwoods (5-8 inches in diameter) died in moderate numbers (10-20 stems per acre) on the upper slopes above Zayante Creek, and redwood bark beetle galleries were present on all the stems examined. The overstory redwoods at this relatively harsh site all displayed very thin, sparse crowns in early fall. Small-

tree suppression on this site was likely more related to competition for water than for light in 2022. Bark beetles capitalized on this stress and killed many smaller diameter trees.

Additionally, 24 mature Sargent cypress (*Cupressus sargentii*) near the headwaters of Austin Creek (Sonoma County) died in association with bark beetle galleries caused by a *Phloeosinus* species (undetermined, likely *P. cupressi*). It is unknown whether the *Phloeosinus* were a significant contributor to cypress mortality. Upslope trees generally survived while trees near the creek died, suggesting that these trees were acclimated to a stable water supply and were disadvantaged by a falling water table during 2022 drought conditions.

Incense-cedar (*Calocedrus decurrens*) mortality in Trinity, Lassen, Siskiyou, and Shasta Counties was patchy but often severe, with up to 1/3 of smaller trees dying in some stands. Damage agents were specific to each stand, attacking trees weakened by drought. Cedar bark beetles (*P. punctatus* and *P. vandykei*) and the amethyst cedar borer (*Semanotus amethystinus*) were the primary insects feeding in the cambium and girdling small trees. Numerous weak to moderately pathogenic fungi were isolated from dead and dying trees.



Sargent cypress mortality associated with cedar bark beetles near Austin Creek (Sonoma County). Photo by: C. Lee, CAL FIRE

Pitch Moths (*Synanthedon* spp.)

In September 2022, pitch moths attacked drought-stressed ponderosa pines and Douglas-fir trees (sequoia pitch moth (*Synanthedon sequoia*) and Douglas-fir pitch moth (*Synanthedon novaroensis*), respectively). Pitch moth attacks (1 - 4) were observed on both injured and uninjured areas of the trunk. Attacked trees were scattered from Lake County to Shasta County. The presence of pupal exuviae on the surface of the pitch masses indicated the moths had completed their life cycle.

Amethyst cedar borer in incense-cedar, northern California. Photo by: C. Ewing, CAL FIRE

Foliar Insects

Douglas-fir Tussock Moth (*Orgyia pseudotsugata*)

Monitoring traps caught large numbers of Douglas-fir tussock moths in parts of the central Sierra Nevada Range this year. Large trap catches indicate there will likely be a noticeable outbreak of the moths on white fir. Douglas-fir tussock moth caused severe white fir defoliation across ~300 acres near Bucks Lake (Plumas County).

California Oakworm (*Phryganidia californica*)

In August, California oakworm severely defoliated coast live oaks (*Quercus agrifolia*) over ~120 acres on the west side of Highway 101 in Orcutt, CA (Santa Barbara County) and ~250 acres on the east side of Highway 1 in Cambria (San Luis Obispo County). Large populations of California oak moth were observed during the summer and fall months in Monterey County, specifically at Pebble Beach.

California oakworm typically has two generations per year but a third generation is possible at warmer sites. Since defoliating outbreaks usually last 1-2 years, oakworm defoliations rarely severely harm or kill healthy trees. Injured trees will be monitored in 2023 to determine if the recent outbreaks affected their health or growth.

Pitch moth mass on ponderosa pine. Photo by: C. Ewing, CAL FIRE

Pitch moth pupal exuviae. Photo by: C. Ewing, CAL FIRE

Coast live oak defoliated by California oakworm in Cambria (San Luis Obispo County).
Photo by: K. Corella, CAL FIRE

Galls caused by poplar petiole aphids on Fremont cottonwood leaves. Photo by: T. Smith, CAL FIRE

Yucca weevil-caused damage on Joshua tree.
Photo by: T. Smith, CAL FIRE

Yucca weevil.
Photo by: T. Smith, CAL FIRE

Poplar Petiole Aphid (*Pemphigus populicaulis*)
An outbreak of poplar petiole aphid on the leaves of Fremont cottonwood (*Populus fremontii*) occurred along the American River near Auburn (Placer County). The aphids caused the formation of galls on the petiole at the base of the leaf blades. Infested leaves turned brown and fell early while uninfested leaves remained green and attached to the tree for longer periods. Although the outbreak was extensive throughout the river valley, the overall damage to trees appeared minimal.

Yucca Weevil (*Scyphophorus yuccae*)
An outbreak of yucca weevil on Joshua trees (*Yucca brevifolia*) caused the foliage to collapse and killed many trees (Los Angeles and San Bernardino Counties). The outbreak may have been related to increasing drought and heat conditions in the desert causing greater stress to the trees. Joshua tree was not previously listed as a host to this weevil.

Pine Tortoise Scale (*Toumeyella parvicornis*)
Pine tortoise scale was identified from a sample collected by an arborist in a residential setting in the Del Mar area of San Diego (San Diego County). The infested trees were treated by the arborist. The scale was later found in 11 established Stone pine/Italian stone pines (*Pinus pinea*). This was the first detection of this pest on the West Coast. A delimitation survey 2 miles around the identification site did not detect additional infested trees. In July 2022, another sample was submitted by an arborist from four residential pines in the Clairemont area (San Diego County), and was followed by a sample from a nursery setting. Several more sites were identified, especially in the Escondido and Rancho Bernardo areas (San Diego County) where many pines were infested. The nursery and arborist are working with a University of California Cooperative Extension (UCCE) entomology advisor on the confirmed sites. Sites are being monitored throughout the county to see how established the scale has become.

Honeydew produced by pine tortoise scales creates favorable conditions for sooty mold growth. Smaller pine trees are more heavily impacted by this pest since they prefer to feed on younger shoots. In some pine trees needles were brown with substantial dieback, others had a few dead branches, and some just grew sooty mold. Other pines had needle dieback but no evidence of

pine tortoise scale. The cause of this dieback is unknown. Sooty mold and honeydew buildup can be substantial, causing the ground below the trees to be sticky and understory plants to be covered in sooty mold.

Balsam woolly adelgid (*Adelges piceae*)

The invasive balsam woolly adelgid was observed on grand fir (*Abies grandis*) in several new locations in coastal California this year. The adelgid was observed on large grand fir branches at Azalea State Reserve in McKinleyville (Humboldt County) where stand decline has also been associated with root and butt rot fungi (*Heterobasidion occidentale*, *Ganoderma brownii*, *Ganoderma oregonense*, and *Armillaria* sp.) and fir engraver beetle.

A stem infestation of balsam woolly adelgid was found on grand fir at Sequoia Park in Eureka (Humboldt County) in a mixed redwood, hemlock, Douglas-fir, and grand fir stand. Large, mature grand firs are declining in this stand. Along the Petrolia Road south of Ferndale (Humboldt County) trees were observed with crown decline and growth forms characteristic of balsam woolly adelgid infestation. A grand fir with a stem-infestation of balsam woolly adelgid but no visible crown symptoms was reported in Jackson Demonstration State Forest along Highway 20 about 10 miles east of Fort Bragg (Mendocino County).

Pine Needle Sheathminer (*Zelleria haimbachi*)

An outbreak of pine needle sheathminer was observed in a privately owned ponderosa pine plantation west of Goose Lake, near the Oregon border (Modoc County). The outbreak was first detected three years ago and has been steadily increasing in size rather than declining as many native defoliator outbreaks do after a few years. Small ponderosa trees (<15 feet tall) were heavily impacted in the epicenter of the infestation. Nearly all trees in the plantation were affected to varying degrees. Branch tips contained ~1-3 larvae. Number of larvae per branch tip is estimated by the number of bundles affected and their distribution on the shoot. Moving away from the epicenter of the infestation only a handful of shoots were attacked on each tree. The lack of natural predators (e.g. yellow jackets or other predaceous wasps) in the area is likely contributing to the population build-up of sheathminer and possibly other defoliators.

Other Highlights

Insects in Fire-Injured Trees

Profuse boring dust, likely caused by ambrosia beetles, was observed on fire-injured giant sequoias from the 2020 Castle and 2021 Windy Fires (Sequoia NF, Tulare County). The boring dust was always found where the wood was exposed and burned – often in older catfaces or at the base where bark had been stripped earlier. This activity was observed on several monarch sequoias in various locations of the wildfires and not isolated to any specific area. Collections of potential insects will be conducted in 2023 using emergence traps.

Woodborers at the Institute of Forest Genetics (IFG)

In February 2022, Northeastern and South Sierra FHP staff examined ~20 pines of various hybrid crosses in a common garden plantation for possible causes of mortality at the USDA Forest Service Pacific Southwest Research Station, Institute of Forest Genetics (IFG) (Placerville, Eldorado County). Large openings in the stand near the center of the garden along with the trees dying along the outer edges of those openings suggest the presence of root disease. Root disease symptoms may have been found here in the past but the species was not confirmed.

Stone pine with damage caused by pine tortoise scale (San Diego County). Photo by: K. Corella, CAL FIRE

Pine needle sheathminer-caused damage on ponderosa pine near Goose Lake (Modoc County).
Photo by: C. Ewing, CAL FIRE

Boring dust, likely left by ambrosia beetles, on giant sequoia, Sequoia NF (Tulare County).
Photo by: B. Bulaon, USDA Forest Service

Three large dead *Pinus ponderosa* x *P. engelmannii* pines were killed by previous insect attacks (possibly in 2021) with one just beginning to fade. Woodborer activity was found under the bark at five feet up the trunk. Resin-soaked wood was found at the root collar. California flatheaded borer (*Phaenops californica*) was the suspected damage agent, but no adults were found at the time. Another nearby hybrid (*P. ponderosa* x *P. arizonica*) also had profuse woodborer activity under the bark but thin white mycelium was layered over those galleries. These pines had resin pockets of unsuccessful woodborers scattered along the trunk. Winding galleries, indicative of western pine beetle, along with black staining was observed on another *P. jeffreyi* and *P. ponderosa* x *P. engelmannii* hybrid, but no exit holes were observed on the outer bark.

P. jeffreyi x *P. ponderosa* x *P. apacheca* hybrid found with western pine beetle galleries, IFG. Photo by: B. Bulaon, USDA Forest Service

Western pine beetle-caused mortality of *P. jeffreyi* x *P. ponderosa* x *P. apacheca* hybrid at IFG. Photo by: D. Cluck, USDA Forest Service

Another group of hybrid pines, *Pinus halepensis* crossed with *P. brutia* were fading (beginning to change color as the tree dies) near the ponderosa hybrids. These trees were also in slow decline: living trees with distressed cone crops, two currently dying, and a few already dead. Woodborers were found under the bark, with signs of woodpecker foraging on the outer bark.

Fresh and old pouch fungus conks (*Cyptoporus volvatus*) were observed on the trunk of all dead pines examined at IFG. Wood samples were taken at the base of trees suspected to have root disease and will be cultured in the lab for identification.

Invasive Insects

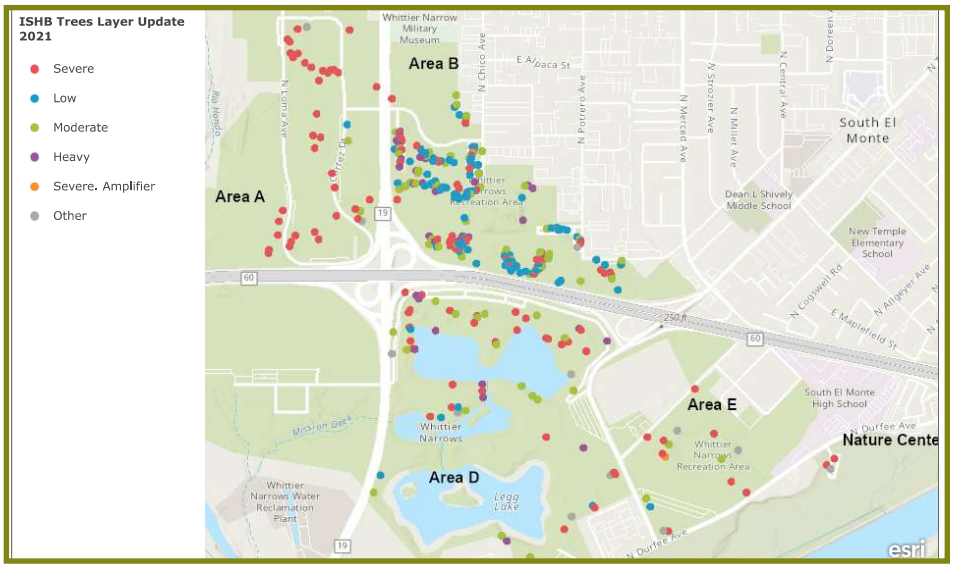
Invasive Shot Hole Borers (ISHB) (*Euwallacea* spp.)
http://www.iscc.ca.gov/ishb.html
http://www.ishb.org
The term invasive shot hole borer (ISHB) refers to two species, the polyphagous shot hole borer (*Euwallacea fornicatus*) and the Kuroshio shot hole borer (*E. kuroshio*). Species level identification is difficult and not often done. Surveys for ISHB were conducted in 2023 in several counties. Survey results are grouped below by county and agency where appropriate.

Los Angeles County
Dozens of London plane (*Platanus* x *hispanica*) and western sycamore (*Platanus racemosa*) with light to moderate infestations and eight trees with severe infestations were observed by LA County Agricultural Commissioner/Weights and Measures (ACWM), City of Malibu, and unincorporated Los Angeles County. Numerous arroyo willows (*Salix lasiolepis*) also had light to moderate ISHB infestations. Dozens of ISBH-infested London plane on public and private lands were reported in Agoura Hills.

Hundreds of black willows (*Salix nigra*), one box elder (*Acer negundo*), five cottonwoods (*Populus* spp.), and sycamore (*Platanus* spp.) with low to severe levels of infestation were identified during the final survey at Devil's Gate Reservoir (Los Angeles County Public Works (LACPW), Hahamonga Watershed Park, Pasadena). In October 2022, five amplifier trees (two black willows and three cottonwoods) and dozens of small (<10 inch diameter) dead, downed, and severely infested black willows were removed. Amplifier trees are trees that are infested with large, population amplifying numbers of ISHB adults and/or developing immature ISHB.

Trapping efforts in Los Angeles County were conducted by ACWM during the spring of 2022. Fifty-three ISHB traps were deployed in two areas of focus. Forty-four traps were placed at Whittier Narrows Recreation Area (LACDPR, South El Monte) in areas where amplifier and hazard trees were removed in 2021, and at the golf course, shooting range, and along the Rio Hondo River. In total, 27 of the traps were positive for ISHB, and were found in all locations of the park where traps were set.

Nine traps were placed on the outskirts of the active restoration area at Devil's Gate Reservoir (LACPW) where five small amplifier trees were identified during the 2021 survey and removed in October of 2022. All nine traps contained ISHB including one with 77 beetles. These trap catches, in combination with the results of the 2021 trapping and tree surveys suggest that ISHB may be coming into the reservoir from the surrounding community.



Location and intensity of ISHB infestations at Whittier Narrows Recreation Area.
Map by: R. Burnap, LA County ACWM

Orange County

Irvine Ranch Conservancy (IRC) staff surveyed 287 trees in Quail Hill, Bommer Canyon, and Shady Canyon in the City of Irvine. New emergence holes were detected on 15 arroyo willows and 16 sycamores. The other 256 trees did not have signs of active infestation. Annual monitoring began in mid-September and is ongoing over the 33.8-acre area of infestation.

Orange County Fire Authority (OCFA) continued to survey Ladera Ranch. Over 1,600 infested trees were identified, including 1,462 California sycamore and 97 Fremont cottonwood. The majority of ISHB infestations were at low levels and more severe infestations were concentrated in two main areas. UCCE began a research trial at Ladera Ranch to test the efficacy of spot injections (injecting treatments directly into active beetle galleries) in 88 moderately to severely infested trees at the two most impacted locations. Results of the study will be reported to the California Department of Food and Agriculture (CDFA). OCFA conducted surveys at four additional properties where 63 trees were identified for removal, but treatments have not been completed. Several homeowner association managed neighborhoods were surveyed within Aliso Viejo, and 262 infested trees were identified. California sycamore was the most impacted tree species followed by Fremont cottonwood. Treatment recommendations were assigned to all trees surveyed, but no treatments have taken place. ISHB traps were set in Aliso Viejo in August of 2020 and continue to be monitored. Multiple amplifier trees in the area were removed or treated, decreasing the number of ISHB found in the traps. Vista Pointe Ridge was identified as an area to re-survey in the future. Treatments appeared to be working in Shady Canyon where few beetles have been caught in traps. Only a few beetles have been caught in ISHB traps within the main riparian corridor at Starr Ranch and at Dove Canyon. Trapping and surveys will continue. If increases in ISHB activity are detected in traps additional surveys may be necessary.

San Bernardino and Riverside Counties

The Inland Empire Resource Conservation District (IERCD) is a government agency headquartered in the City of Redlands that focuses on open space preservation, wildland rehabilitation, and education and outreach to residents within 1,286 square miles of northwestern Riverside and southwestern San Bernardino Counties. IERCD conducted ISHB surveys in 2022 and found ISHB activity has significantly increased resulting in branch dieback and tree death. Increases in activity were observed in Chino Hills State Park (Orange, Riverside, and San Bernardino Counties), primarily the northwestern border of the park near the Discovery Center. Approximately 8-24 host plants were infested, including arroyo willow, California sycamore, and one castor bean (*Ricinus communis*).

San Diego County

The Center for Natural Lands Management (CNLM) preserve located at Rosemary's Mountain Quarry in Oceanside and the Encinas Creek Preserve in Carlsbad have infestations of ISHB of approximately 8.5 acres and 12 acres, respectively. Hundreds of Goodding's black willow (*Salix gooddingii*), arroyo willow, red willow (*Salix laevigata*), and Fremont cottonwood were infested

at both locations. The ISHB infestation was first observed in 2016 at the Rosemary's Mountain Quarry and in 2018 at Encinas Creek Preserve. Infestations caused crown dieback and branch dropping, but the habitat is recovering and regrowth is occurring throughout the preserve.

A total of 99 western sycamore, Fremont cottonwood, coast live oak, castor bean, arroyo willow, and black willow were identified as infested with ISHB at Coyote Hills East Preserve located in Fullerton (Orange County). Six have died.

Goldspotted Oak Borer (GSOB) (*Agrilus auroguttatus*)

www.gsob.org

Los Angeles County

Bouquet Canyon is a deep V-shaped southern aspect canyon in Los Angeles County above Santa Clarita Valley where a blue-line stream originating from Bouquet Canyon Reservoir supports a vibrant riparian oak woodland. The zone extends about 1,000 feet up hillsides and rapidly transitions into scrub habitat. The GSOB-affected area is in the Angeles NF and includes at least 12 private inholdings, many of which are undeveloped, along with permitted Forest Service cabins. A Forest Service forester detected and recorded five coast live oaks infested with GSOB in the canyon, and the owner/operator of a Los Angeles Department of Water and Power (LADWP) reservoir site recorded one tree infested with GSOB. In July 2022, a team comprised of community members, a GSOB expert with the La Jolla Band of Luiseño Indians, and UC - Riverside staff determined via a rapid visual survey that a GSOB infestation was widely spread throughout the canyon. Wood is the primary heat source for residents and cabin permit holders, and firewood is routinely gleaned and shared from local downed oaks in the community. Residents of the community indicated that GSOB has been present in firewood from local trees for at least six years and they were unaware of the threats posed by the pest.

Orange County

University of California Agriculture and Natural Resources (UC ANR) positively identified new GSOB infestations on coast live oaks at multiple locations in 2022. At Anaheim Hills Golf Course infested trees are being treated and removed. Initial surveys identified ~12 infested trees in Starr Ranch, and several infestations were recorded in a large residential area in Santa Ana. New infestations were also identified at Modjeska Canyon Nature Preserve and Silverado Canyon.

Irvine Ranch Conservancy staff surveyed 194 coast live oak trees in Weir and Gypsum Canyons, a 66% decrease in the number of trees surveyed, in which GSOB infestation rates remained consistent with last year – there were no new exit holes on 96% of surveyed trees in 2021.

San Bernardino County

The GSOB infestation in the community of Oak Glen covers ~117 acres, including the hillsides and stream corridors of Oak Knoll Park, Pisgah Peak. GSOB activity has increased significantly in the Wildland Conservancy-run Oak Glen Preserve. The affected area includes the historic Los Rios Rancho and current Oak Glen Preserve and Botanic Garden which have highly-valued, large oak trees of varying species. Mitigation efforts have been ongoing in this area since GSOB was first detected in the area in 2018. Dead and dying GSOB-infested trees are cut and chipped. Preventative insecticides are applied by trunk injection or topically to save live trees. GSOB is difficult to manage in this area since it is widespread in the area and many susceptible trees are not able to be treated using insecticides. Smaller diameter trees (<15 inches diameter), which are less preferred than large diameter trees, are currently being attacked by GSOB likely due to the severe impacts of the 2020 El Dorado Fire on larger diameter oak trees.

IERCD identified a GSOB infestation of coast live oaks in a 10–15-acre campground south of Wildwood Canyon State Park and followed up with management activities.

State Parks continued and expanded GSOB monitoring and management through ground surveys at Mt. San Jacinto State Park's Idyllwild and Stone Creek Campgrounds. Trees at both campgrounds receive annual basal applications of dinotefuran with a surfactant (i.e., Pentra-bark™), and heavily infested trees are removed as needed (average of two removals per year). Treatments and removals have been ongoing since 2018 at Idyllwild Campground and since 2020 at Stone Creek Campground. The infestation appears to have slowed on treated trees at both sites.

Ground surveys assessing GSOB infestation in the open space east and northwest of Stone Creek Campground occurred this year. California black oak (*Quercus kelloggii*) and, less frequently, canyon live oak (*Quercus chrysolepis*) were infested. Preliminary data suggest that GSOB is widespread and established within open space areas at Mt. San Jacinto State Park.

Wildwood Canyon, a State Park property near the city of Yucaipa, was surveyed for GSOB for the first time in 2022. Surveys covered ~55 acres of coast live oak along Oak Loop Trail and included 115 tagged trees within plots. Two coast live oak trees were identified as GSOB-infested and removed.

Using survey data collected by the IERCD, CAL FIRE crews cut and chipped four trees heavily infested by GSOB in Edgar Canyon in early May. Edgar Canyon is located between the community of Oak Glen and the City of Cherry Valley near the San Bernardino/ Riverside County border. Due to accessibility, chipper capability, and crew availability, some GSOB-infested material could not be chipped and instead was covered with aluminum mesh screening.

In the mountain inter-jurisdictional community of Wrightwood, GSOB was identified in California black oak a few years ago. Although no formal surveys have been conducted in Wrightwood, widespread infestation is suspected in the area. A GSOB infestation has also been reported in a higher-elevation area in a community south of Wrightwood, however it is believed the two infestations are independent of one another. The Wrightwood Fire Safe Council (FSC) is highly organized and has assembled a comprehensive group of stakeholders, including local, county, state, federal, and academic partners. CAL FIRE recently drafted the *Wrightwood GSOB Rapid Response Plan*, which was approved and adopted by the community. GSOB surveying is the top priority of both the plan and the FSC.

San Diego County

The Pala Band of Mission Indians found two GSOB-infested trees at one plot during a systematic forest inventory survey of 31 plots over 210 acres of oak woodlands. The two infested trees were removed and tarped.

For the sixth consecutive year, the contact insecticide carbaryl was applied to ~256 coast live oaks on the Palomar Ranger District (Cleveland NF) across four sites: Oak Grove Campground, Oak Grove Fire Station, Inaja Memorial Picnic Area, and Pine Hills Fire Station near Julian.

In June 2022, carbaryl was applied to ~1,157 coast live oaks for the fourth consecutive year at eight developed recreation sites located adjacent to Ortega Highway and west of Lake Elsinore: Blue Jay Campground, Falcon Group Campground, adjacent oak woodland along Long Canyon Road, areas between the aforementioned sites, Wildland Fire Fighter Memorial, El Cariso Picnic Areas (North and South), El Cariso Campground, and the shared Forest Service, Riverside County Fire Station (Trabuco Ranger District, Cleveland NF).

Carbaryl application services on both of the above mentioned Districts were performed by USDA Forest Service procured contractors with funding provided through FHP.

Goldspotted oak borer populations continued to increase in the Community of Oak Grove, which is part of the Resource Conservation District of Greater San Diego County. Approximately 1,785 trees at Oak Grove, and more in surrounding communities, were sprayed in 2022.

In 2020 the La Jolla Band of Luiseño Indians began implementing a GSOB Pest Management Plan on the La Jolla Indian Reservation. The plan includes pesticide application of 300 trees annually, tree removal, planting and propagation, and infested wood processing. In 2022 the Tribe removed 250 large oak trees and marked 350 more for removal. The Tribe has received funding to support GSOB management from a variety of sources including: California Department of Conservation, Resource Conservation District, Indigenous Stewardship Network, Bureau of Indian Affairs (BIA), and Natural Resource Conservation Service (NRCS). The BIA awarded the Tribe funding to purchase forestry equipment and a wood kiln that will heat treat infested wood and provide a local source of insect-free firewood in 2023. In addition, the USDA Forest Service Special Technology Development Program has funded the Tribe to develop Indigenous Cultural and Prescribed Burning recommendations for GSOB Management. The Tribe works in close collaboration with the UC - Riverside Entomology Department and is using this opportunity to develop capacity for fuels and restoration work and to invest in the community workforce by providing local jobs and training opportunities.

Mediterranean Oak Borer (*Xyleborus monographus*)

https://ucanr.edu/sites/mobpc/

Mediterranean Oak Borer (MOB) was first identified in Napa County in the fall of 2019 and subsequent surveys of dead and dying trees in the area indicate it had probably been present since 2010-2014. The current distribution of the invasive insect includes Sonoma, Lake, Napa, and Sacramento Counties. MOB is apparently expanding its geographic range through dispersal flights and transport in unseasoned firewood. MOB females reach maturity in the fall when they mate and remain inside the wood until the temperatures reach approximately 80° F during the day, which has been observed as early

Valley oak wood heavily infested with MOB gravid females in mid winter. Photo by: C. Ewing, CAL FIRE

as mid-January in Napa County. Since 2021 MOB distribution has spread farther west in Sonoma County to U.S. Route 101 and has been detected in valley (*Quercus lobata*) and blue oaks (*Quercus douglasii*) from Cotati to north Santa Rosa. Valley oaks were tagged in Napa County in 2020 and in 2021 plots were established in Napa and Sonoma Counties in unburned areas and in areas that sustained moderate damage during the 2020 Glass Fire. Reevaluation of the 2020 plots showed continued steady decline among the tagged valley oaks. The 2021 plots included valley and blue oaks in Napa County and blue and Oregon white oak (*Quercus garryana*) in Sonoma County. Both burned and unburned areas had increased levels of MOB attack for valley and blue oaks in Napa. In Sonoma County, where the plots are ~1 mile from the nearest trap capture, no MOB was detected in either blue or Oregon white oak. These plots will be monitored for at least 4 more years.

Non-Native Insects Unknown in California

Spotted Lanternfly (*Lycorma delicatula*)

Viable and non-viable life stages of the spotted lantern fly were detected at CDFA Border Stations where any insects found were destroyed. As many agricultural crops and forest and shade tree species are known hosts for this invasive insect pest, CDFA has established a state interior quarantine to reduce the potential of this destructive insect entering California.

Canker Diseases

Canker-causing pathogens (various species)

Several canker-causing pathogens were isolated from drought-stressed trees throughout the North Coast in 2022. Several of these pathogens were isolated from branch-flagged, top-dead, and fading incense-cedars in Siskiyou, Humboldt, and Mendocino Counties over the past few years. In 2022, one flagging incense-cedar branch from a location just north of Laytonville along Highway 101 yielded *Cytospora eucalypti*, *Hormonema viticola*, and *Dothiorella californica*; bay laurels (*Umbellularia californica*) dying-back at Redwood Regional Park east of Healdsburg (Sonoma County) also harbored *Dothiorella californica*. At the same park, dying mature coast redwood trees (*Sequoia sempervirens*) had lesions on small-to-medium-sized roots caused by *Neofusicoccum australe*. North of Cazadero, on a west-facing slope above the headwaters of Austin Creek, a *Seiridium* species was isolated from the roots of a dying Sargent cypress. This tree was in the middle of a ~2-acre patch of Sargent cypress trees that have been slowly dying, starting from the center and expanding outward, for the past decade. Multi-locus sequencing of the recovered isolate suggested that it was closest to *Seiridium pseudocardinale* or *Seiridium kenyanum*, neither of which are known to be from the United States. An isolate collected from dying incense-cedar in 2020 in Humboldt County was also identified as closest to *S. pseudocardinale* (see 2020 Forest Pest Conditions Report).

Cankers caused by various pathogenic fungi on tanoaks (*Notholithocarpus densiflorus*) and true oaks (*Quercus* spp.) were also widespread in the North Coast in 2022, with their impact potentially magnified by drought stress. These included *Tubakia californica* on twigs and small branches, *Eutypa lata* on small branches, *Diaporthe* spp. on twigs and small branches, and *Diplodia corticola* on material of all sizes, from trunks to twigs. In some parts of the Bay Area, defoliation of coast live oaks, blue oaks, and valley oaks was detected from aerial detection surveys and was investigated and found to be related to several possible causes. For example, blue oak defoliation appeared to be a consequence of late-summer dry conditions, as leaves were browning and dropping from canopies in a uniform manner, while *Gnomoniopsis clavulata* was found on coast live oak leaves and *Cytospora diatrypelloidea* was isolated from bleeding coast live oak trunk cankers – these agents may have been more aggressive because of drought stress.

Extensive cankering and dieback of tanoak and true oak were reported in the Butte and Placer County foothills near the New Bullards Bar Reservoir. Symptoms mimicked sudden oak death (*Phytophthora ramorum*), however laboratory isolates found *Tubakia californica* to be the main cause. Hundreds of trees were impacted.

Foamy bark canker on Japanese maple.
Photo by: S. Latham, CDFA

Foamy Bark Canker (*Geosmithia* sp.)

The pathogen causing foamy bark canker of oaks in California was identified from a Japanese maple (*Acer palmatum*) in Alameda County. Previously the disease had only been identified from infected oaks. The fungus was previously thought to be *G. pallida*, but recent molecular work suggests it is likely a novel species. The fungus causes cankers surrounding the galleries of western oak bark beetle (*Pseudopityophthorus pubipennis*). Drought-stressed trees appear to be more prone to beetle attack and more susceptible to *Geosmithia* sp.

Foamy bark canker on Japanese maple.
Photo by: S. Latham, CDFA

Botryosphaeriaceae Cankers (numerous fungi including *Neofusicoccum*, *Diplodia*, *Dothiorella*, *Macrophomina*, and *Botryosphaeria* spp.)

Numerous “Bot” canker fungi were identified from a variety of host species. The "Bot" fungi were once considered to be *Botryosphaeria* spp. but have been reclassified within separate taxa in the Botryosphaeriaceae. The causal species vary by host. *Diplodia corticola* is

widespread on oaks (*Quercus* spp.) in California and is causing dieback and canker symptoms. There is an increasing incidence on tanoak in the north Bay Area and along the North Coast. Trees looked drought-stressed and had trunk and branch cankers, dieback, and thinning canopies.

Neofusicoccum arbuti causes a "Bot" canker of madrone (*Arbutus menziesii*) but was detected on multiple stressed monkey puzzle trees (*Araucaria araucana*) in the Bay Area. Monkey puzzle is a non-native host but is planted in some urban areas of the state. Finding *Neofusicoccum* on monkey puzzle indicated the fungus' ability to move to other host species under drought or other stress conditions.

Shoot Blight of Bishop Pine (various fungi)
Shoot blight on bishop pine seedlings was sampled at restoration sites on Santa Rosa Island, Channel Islands NP (Santa Barbara County). Disease incidence was approximately 40%. CDFA identified the following species using DNA sequencing: *Diplodia* sp., *Pestalotiopsis* sp., *Pestolotia* sp., *Sydowia polyspora*, *Diaporthe* sp., *Cyclaneusma minus*, *Truncatella angustata*, *Alternaria alternata*, and *Diplodia sapinea*.

Sooty Bark Canker of Maple (*Cryptostroma corticale*)
In the fall of 2022, sooty bark canker (also known as maple sooty bark disease) was detected in silver maples (*Acer saccharinum*) and a single Norway maple (*A. platanoides*) in Elk Grove (Sacramento County). This was the second detection of this pathogen by the CDFA in California. The previous detection was in El Dorado Hills on red maple (*A. rubrum*) in 2019 (El Dorado County). The disease is associated with mortality of trees under heat and drought stress, and the spores are associated with serious pulmonary disease in humans. The continued spread of this disease may impact populations of bigleaf maple (*A. macrophyllum*), a species that is susceptible to sooty bark canker, especially in drought and heat stress conditions. The disease is native to the Michigan area but has been recently reported in the Puget Sound region of Washington State.

Diplodia corticola canker on tanoak.
Photo by: S. Latham, CDFA

Shoot blight symptoms on bishop pine on Santa Rosa Island.
Photo by: C. Barnes, USDA Forest Service

Neofusicoccum canker on monkey puzzle tree in the Bay Area.
Photo by: S. Latham, CDFA

Sooty bark canker on silver maple in Sacramento County.
Photo by: C. Ewing, CAL FIRE

Close-up of sooty bark canker.
Photo by: C. Ewing, CAL FIRE

Pitch Canker (*Fusarium circinatum*)
In 2022, Pitch canker was detected on one mature Monterey pine in the California Coastal National Monument, just north of Point Arena (Mendocino County). Symptoms were not yet widespread on the tree, but *Diplodia scrobiculata* has caused large-scale seedling mortality, and Monterey pine ips, the butt-rotting fungus *Onnia subtriquetra*, and western gall rust (*Cronartium harknessii*) have attacked mature Monterey pines. The detection of pitch canker at this site expands its known distribution to approximately 17 miles north of the Sonoma-Mendocino County line.

Small Monterey pine being killed by the pitch canker pathogen near Timber Cove in Sonoma County. Photo by: C. Lee, CAL FIRE

Wilt Diseases

Fusarium Wilt or Palm Wilt (*Fusarium oxysporum* f. sp. *palmarum*)
In 2003, a new palm wilt disease of queen palm (*Syagrus romanzoffiana*) and Mexican fan palm (*Washingtonia robusta*) was first identified in Florida. In 2019, it was identified in Southern California attacking both palm hosts and in September 2021, it was confirmed on a queen palm in a residential landscape in the Sacramento area. Symptoms include atypical one-sided dieback of fronds, similar to Canary Island palm wilt (*Fusarium oxysporum* f. sp. *canariensis*). The queen and Mexican palm wilt strain appears to cause more rapid decline than the Canary Island palm strain. Both strains are fatal and there are no known treatments.

Fusarium wilt of palm. Photo by: S. Latham, CDFA

Foliar Diseases

Leaf Spot of Island Oak (various species)
Leaf spots on island oak (*Quercus tomentella*) leaves were very common on Santa Rosa Island (Santa Barbara County). CDFA sequenced samples from symptomatic leaves and identified *Diplodia* sp., *Coryneum* sp., *Pestalotiopsis chamaeropis*, and *Tubakia* sp. This may be the first report of *Tubakia* sp. on island oak.

Wood Staining Fungi

Miscellaneous Wood Staining Fungi (various species)
In 2022, investigations of blue and black-staining fungi in various conifers revealed a wide diversity of xylem-infecting fungi, associated in most cases

with beetle vectors. In Santa Cruz County, the fungi *Ophiostoma gilletteae* and *Ophiostoma minus* were isolated from ponderosa pine that had been dying at a rate of 2-3 trees per acre every year. *Leptographium terebrantis* was previously isolated from these trees. At Briones Reservoir in Contra Costa County, *Grossmannia americana* (*Leptographium americanum*) was isolated from the roots of a dying Monterey pine. *Ophiostoma pseudominus* was associated with the galleries of the ambrosia beetle on Douglas-fir in Jackson Demonstration State Forest (Mendocino County; see "Douglas-fir beetle" in the Insects section).

***Leptographium* Wood Stain** (*Leptographium terebrantis*)
Dieback of ponderosa pine was observed across ~15 acres at Quail Hollow Quarry (Santa Cruz County). *L. terebrantis*, a weak pathogen that causes lesions in the phloem and resin-soaking of the xylem in both seedlings and mature conifers, was isolated from dying and declining ponderosa pine. First observed in 2019, the number of dying pines has increased each year.

Leptographium terebrantis on ponderosa pine.
Photo by: K. Corella, CAL FIRE

Oomycete Pathogens

Oomycete Branch, Twig, and Foliar Disease (various species)
In the North Coast, several oomycetes (water molds) other than *Phytophthora ramorum* were detected in 2022. *P. ramorum* was detected on one tree in Del Norte County in 2019, but subsequent site visits and samples from the tree failed to redetect *P. ramorum*. In 2022, *Phytophthora nemorosa* was recovered from symptomatic branches of the same tree, along with *Diplodia corticola*. Cankers suspected to be caused by *Phytophthora siskiyouensis* were observed on red alders in McKinleyville and Fieldbrook (Humboldt County). In each case there were on only 1-2 alders (*Alnus* sp.) per site.

Long-term severe dieback of bishop pine, evergreen huckleberry (*Vaccinium ovatum*), and Pacific wax myrtle (*Myrica californica*) has been observed at a site near Iverson Road in Mendocino County. *Elongisporangium undulatum* (=*Pythium undulatum*/*Phytophthora undulata*) was recovered for the second time from saturated soil at the base of the declining shrubs. Damage associated with *Phytophthora cinnamomi*, apparent in both conifers and hardwoods, was also noted in several places in Salt Point State Park and at Sea Ranch (Sonoma County).

Madrone dieback associated with *Phytophthora cinnamomi* at Sea Ranch (Sonoma County). Photo by: C. Lee, CAL FIRE

Oomycete Root Diseases (various species)
Symptoms of infection by various oomycete pathogens were observed in Del Norte County in 2022. Numerous Port-Orford-cedars (*Chamaecyparis lawsoniana*) died along State Routes 197 and 199 near Hiouchi at sites where *Phytophthora cinnamomi* was previously recovered; it is likely that both *P. cinnamomi* and *P. lateralis* are present in these sites. The presence of *P. lateralis* was obvious along South Fork Road on the banks of the South Fork Smith River, where Port-Orford-cedar mortality was more noticeable in 2022 than in 2021. *P. cambivora* was recovered from soil beneath dying chinquapins along French Hill Road above Hurdygurdy Creek (a tributary to the South Fork Smith) in 2020, and additional chinquapins were dying at the site when surveyed in October 2022.

Tanoak killed by *Phytopthora ramorum* in Gualala (Mendocino County).
Photo by: C. Lee, CAL FIRE

Sudden Oak Death (SOD) (*Phytophthora ramorum*)
Citizen scientists participating in the UC-Berkeley-led SOD Blitz 2022 confirmed that new *Phytophthora ramorum* infections statewide appeared to be at lower levels than previous years, likely due to dry winter and spring conditions. Reductions in new bay laurel and oak (*Quercus* spp.) infections, as well as in oak and tanoak mortality, were observed widely from Big Sur in the south to Humboldt County in the north. Notable sites where SOD outbreaks did intensify in 2022 included parts of Redwood NP in Humboldt County, northeast-facing slopes along Highway 128 in southern Mendocino County, the southern Mendocino County/northern Sonoma County coast, other parts of western Sonoma County, southern and western Marin County, the Oakland Hills, and the Santa Cruz and Santa Lucia Mountains. Scattered newly dead coast live oaks near Almaden and Guadalupe Reservoirs in Santa Clara County were suspected of being killed by *P. ramorum* as well. Although tanoak mortality in the Salmon Creek drainage at the Monterey-San Luis Obispo County border continued to be noteworthy, once again neither watercourse nor terrestrial sampling within San Luis Obispo County proper detected the pathogen.

In late 2021 and early 2022 CAL FIRE and UCCE Humboldt-Del Norte detected a satellite EU1 infestation near the site where, in 2020, known infected and buffer trees were removed. These new detections were later confirmed by UC-Berkeley as part of the SOD Blitz. The infested area appears to be approximately 0.5 ac (~0.25 ha) in size. Further surveys and planning for treating this infestation were underway, as was discussion of the optimal size and location for a requested expansion of the Board of Forestry SOD Zone of Infestation into Del Norte County.

Sitka spruce stand near Big Lagoon (Humboldt County) with declining crown conditions associated with green spruce aphid, *Phaeolus schweinitzii*, and *Heterobasidion occidentale*. Photo by: C. Lee, CAL FIRE

Root Diseases

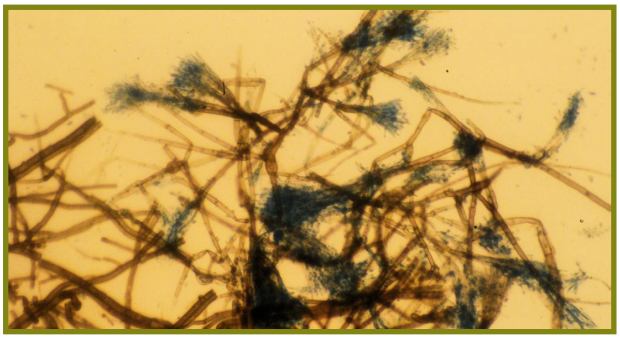
Heterobasidion Root Disease
(*Heterobasidion occidentale* and *H. irregulare*)
Fruiting bodies of *Heterobasidion occidentale* were observed in a stand of Sitka spruce (*Picea sitchensis*) near Big Lagoon (Humboldt County). The spruce had been declining in association with other pests observed in the vicinity including green spruce aphid (*Elatobium abietinum*) and the velvet top fungus (*Phaeolus schweinitzii*). Approximately ten acres of mature spruce trees had declining crowns, and snags and fallen trees were scattered throughout the stand indicating ongoing decline for some time.

In 2022, USDA Forest Service Aerial Detection Survey mapped 280,000 acres of true fir (*Abies* spp.) mortality in northeast California. In late summer 2022, FHP staff confirmed that three of the areas mapped with true fir

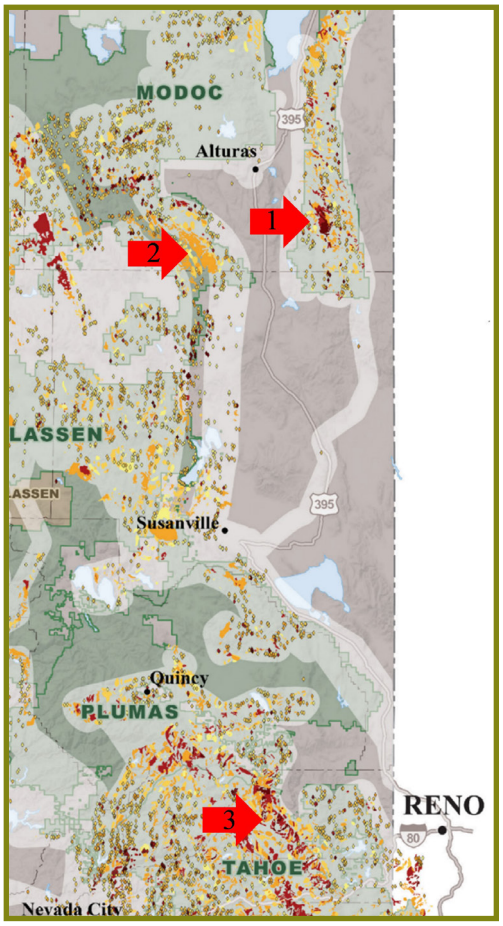
Fruiting body of Heterobasidion occidentale recovered from Sitka spruce stump near Big Lagoon (Humboldt County). Photo by: C. Lee, CAL FIRE

Dead white fir associated with Heterobasidion Root Disease. Photo by: W. Woodruff, USDA Forest Service

mortality also had widespread Heterobasidion root disease (HRD). In addition to mortality, many of the true fir trees in these areas had dead tops and long-term suppressed growth associated with HRD. The suppressed growth in affected trees was indicated by reduced height, short terminal leaders, and prematurely rounded treetops. Signs of HRD (fungal fruiting bodies and delaminated wood in stumps) were also present. HRD signs and symptoms were common in most old-growth true fir areas in northeastern California.



Microscopic view of *Leptographia* heads, possible black stain root disease. Photo by: M. MacKenzie, USDA Forest Service



2022 Aerial Detection Survey map of NE California. Red arrows indicate where Heterobasidion root disease is associated with the mapped true fir mortality. Map: Aerial Detection Survey Program, USDA Forest Service

Black Stain Root Disease (*Leptographium wageneri*)

Signs of attack by red turpentine beetle and blue staining fungi were found on some ponderosa pine trees that were killed by western pine beetle in the Eldorado NF. A *Leptographium* species, the cause of black staining was recovered. It was possible that red the turpentine beetle, brought the black stain into the tree or that the beetles were attracted to trees already impacted by black stain root disease.

Rhizoctonia Root Disease (*Rhizoctonia* spp.)

Rhizoctonia species were recovered in association with tree decline or dieback at several locations in the North Coast in 2022. Taxonomy and identification of this group is difficult, partly because *Rhizoctonia* spp. do not produce reproductive structures. A *Rhizoctonia* sp. was identified morphologically after isolation from small root lesions on a declining bishop pine at Sue-Meg State Park (Humboldt County). Root-infecting *Rhizoctonia* spp. on trees are often secondary pathogens, indicating that these very old pines were stressed, most likely from active competition from Sitka spruce trees, and the more-than-overhead-height huckleberry (*Gaylussacia* sp.) and salal (*Gaultheria shallon*) shrubs. *Rhizoctonia fraxini* was also recovered from the roots of declining coyotebrush (*Baccharis pilularis*) along the Bear River in Humboldt County, in association with an unidentified root borer. A fungus closely related to *Rhizoctonia* was recovered from twig cankers on tanoak in Redwood NP (Humboldt County); this was unusual, since most *Rhizoctonia* species require very high levels of ambient moisture to survive and infect aerial plant parts (see “Web Blight” in the 2021 Forest Pest Conditions Report).

Heart and Sap Rot Fungi

Velvet Top Fungus (*Phaeolus schweinitzii*)

This root- and butt-rot fungus was observed fruiting with higher frequency in the North Coast in 2022 than in 2021, likely because of an October rain in the northernmost coastal counties. A large specimen of note was seen high up on the trunk of a 90-inch-diameter Sitka spruce, adjacent to Highway 101 just south of Del Norte Coast Redwoods State Park (Del Norte County). The California Department of Transportation (CalTrans) removed the potential hazard tree, revealing extensive hollowing of the butt as well as decay of portions of the outer sapwood associated with the fruiting bodies.

Phaeolus schweinitzii fruiting on large Sitka spruce adjacent to Highway 101 between Klamath and Crescent City (Del Norte County). Photo by: C. Lee, CAL FIRE

Fruiting body of *Onnia* sp., most likely *O. subtriquetra*, on Monterey pine at the California Coastal National Monument near Point Arena (Mendocino County).
Photo by: C. Lee, CAL FIRE

Onnia Rot (*Onnia subtriquetra*)
Fruiting bodies of this butt-rotting pathogen were found on Monterey pine and bishop pine at various locations in the North Coast counties. In 2022, primary locations included Stump Beach in Salt Point State Park (Sonoma County) and the California Coastal National Monument near Point Arena (Mendocino County). The pathogen's identity is provisional and based on Internal Transcribed Spacer (ITS) sequencing of one specimen; further specimens were being collected to refine the identification. Since it can be difficult to distinguish these fruiting bodies from those of *Phaeolus schweinitzii* in the field, these collections will also be oriented toward enumerating distinguishing morphological characteristics.

Coast Redwood Sapwood Decay
(*Coniophora puteana*)
Within the footprint of the 2020 CZU Complex Fire in Santa Cruz County, widespread incidence of a decay fungus producing thin, grayish-white, crustose fruiting bodies on the outside of fire-burned redwood stems (both living and dead) was reported in 2022. The fruiting bodies, produced in spring, were short-lived and consistently associated with extensive decay of the sapwood. DNA extraction and PCR-sequencing analysis confirmed the identity of this fungus as *Coniophora puteana*.

Oak Heart Rot (*Ganoderma* sp.)
Throughout 2022, a *Ganoderma* sp. was found on multiple coast live oaks on the Pechanga, Pala, Jamul, and Soboba tribal lands, and at the Indian Flats and El Cariso Campgrounds (Riverside and San Diego Counties) and may represent more than one species. Overall, this covers an area of ~2 million acres across Southern California. Not all samples were sequenced, but the sample from the El Cariso Campground used the ITS region and the partial translation elongation factor 1 alpha (TEF-1α) gene. This *Ganoderma* sample does not match any other *Ganoderma* species in GenBank and may be a new species. Sequence work was done in collaboration with the University of Minnesota, Forest Pathology lab.

A laccate *Ganoderma* sp. conk at the base of a coast live oak, *Q. agrifolia*, at the El Cariso campground. Photo by: C. Barnes, USDA Forest Service

Old conk of *Pyrofomes juniperinus* var *earlei* infecting Sierra juniper, *Juniperus grandis*. Photo by: C. Barnes, USDA Forest Service

Young conk of *Pyrofomes juniperinus* var *earlei* infecting Sierra juniper, *Juniperus grandis*. Photo by: C. Barnes, USDA Forest Service

Distribution of *Juniperus grandis*, in southern California in yellow. Observations were made of the population directly east of Los Angeles. Map by: Calscape (https://calscape.org/Juniperus-grandis)

Juniper Heartrot (*Pyrofomes juniperinus*)
The Sierra juniper (*Juniperus grandis*) was infected by *Pyrofomes juniperinus* var. *earlei*. Conks were found on 10-15% of the juniper trees in the southern California population (see map). Most of the *Pyrofomes* infected trees also had leafy mistletoe. The

presence of older and younger conks indicated the disease has been in the area for some time. The last recorded observations were made in 2019.

Western gall rust, *Cronartium harknessii*, on bishop pine, *Pinus muricata*, on Santa Rosa Island.
Photo by: C. Barnes, USDA Forest Service

Rust Diseases

Western Gall Rust (*Cronartium harknessii*)

The western gall rust pathogen was found on 20-30% of the bishop pine on Santa Rosa Island (Santa Barbara County) in October 2021. The location covered ~8 acres, but not all groves were scouted on the 54,000-acre island. The galls were not active, relatively old, but easy to find. CDFA performed DNA sequencing to verify the pathogen.

White Pine Blister Rust (*Cronartium ribicola*)

White pine blister rust was collected and the sequence verified from *Ribes aureum* at two locations on private lands in Los Angeles and San Bernardino Counties, an urban and a rural location respectively. Sequencing was done at the University of British Columbia, Department of Forest and Conservation Sciences. In May 2022, rust severity on the *Ribes* at the urban location was 70-90% on 70-90% of the leaves (incidence), however, at the rural location rust severity and incidence were much lower. The elevation and climate differences between the urban site (~700 ft altitude) and the rural site (~5,000 ft altitude) may account for this difference in the timing of the rust life cycle. By fall, the infection levels at the rural location were as high as at the urban site in May. Importantly, no telia have been observed at either location to date. The disease has yet to be found on any pine (*Pinus* spp.) hosts in these areas.

Rust infected leaves from multiple *Ribes* plants.
Photo by: C. Barnes, USDA Forest Service

White pine blister rust, *Cronartium ribicola*, on *Ribes aureum* at a rural location, approximately 5,000 feet elevation, San Bernardino County.
Photo by: C. Barnes, USDA Forest Service

Mistletoes

Oak Leafy Mistletoe (*Phoradendron villosum*)

Leafy mistletoe was observed on roughly half of the blue oak, at Oak Flat Campground on the Angeles NF. The observed infested area was ~90 acres. Blue oak, typically a drought tolerant tree, was declining at this site due to the ongoing severe drought conditions. The mistletoe may add to the stress on these oaks, or hinder recovery from the drought.

Juniper Mistletoe (*Phoradendron juniperinum*)

High levels of juniper mistletoe, *Phoradendron juniperinum*, were observed on western juniper, *Juniperus grandis* (formerly *Juniperus occidentalis* ssp. *australis*; from USDA Plants Database https://plants.sc.egov.usda.gov/home/plantProfile?symbol=JUGR7

Leafy mistletoe, *Phoradendron villosum*, on blue oak, *Q. douglasii*, at the Oak Flat Campground, Angeles NF. Photo by: C. Barnes, USDA Forest Service

Leafy mistletoe on *Juniperus grandis* at the Meadows Edge picnic area in the San Bernardino NF. Photo by: C. Barnes, USDA Forest Service

Leafy mistletoe on Juniper seedlings near Big Bear Lake, California Photo by: C. Barnes, USDA Forest Service

accessed March 24, 2023) in one of the southern-most distribution areas of this juniper, directly east of Los Angeles. The area observed was near Big Bear Lake and ~100 acres in size. Average infection levels over the entire area were 30-40%, but there were some areas where nearly every tree was infected, including seedlings, particularly near the Big Bear Discovery Center.

Climate-driven tree die-off and decline in the San Francisco Bay Area (climate stress and several biotic agents)

Several years of drought combined with heat waves resulted in a complex mosaic of tree mortality across the Central Coast. In 2022, drought- and bark beetle-caused tree mortality increased, especially in Lake, Napa, and other North Bay Area Counties. Dieback and mortality were also elevated on acacia (primarily *Acacia melanoxylon*, blackwood acacia), eucalyptus (mainly *Eucalyptus globulus*), manzanita (*Arctostaphylus manzanita*, *A. glauca*, and *A. auriculata*), and knobcone pine in Alameda, Contra Costa, and other Bay Area counties.

The acacia and eucalyptus dieback, called "sudden tree die-off" by the East Bay Regional Parks District, first became apparent in Fall 2020. Attributed to drought accompanied by exceptional heat waves, a widespread decline of several hardwood and conifer species occurred throughout much of the Greater San Francisco Bay Area.

In 2020, blackwood acacia and silver wattle (*Acacia dealbata*) mortality developed in many Bay Area locations (concentrated most prominently in the Leona Heights/Montclair and Dimond Canyon areas of Oakland) but did not expand significantly in 2022. The bright red recently killed acacias that lined freeways and undeveloped areas in 2020 had faded. Acacia is not native to the Bay Area and frequently establishes in vacant lots or unmanaged sites. On the edges of the mortality centers a few individual trees declined in 2022, but many trees resprouted and produced abundant new foliage. The primary symptom on many of the acacia was extensive bole cankers caused by several endophytic fungi mainly *Diaporthe foeniculina* and *Dothiorella viticola*. Additionally, *Dothiorella moneti* was found in Leona Heights/Montclair where it was associated with stand-level mortality.

Eucalyptus throughout Alameda and Contra Costa Counties died back in 2020, but generally the trees resprouted copious leaves along their boles and primary branches, likely because only weak pathogens were isolated from the dissected eucalyptus. *Pseudosydowia eucalypti* (synonyms *Sydowia* and *Sphaerulina eucalypti*) was the fungus most commonly isolated from the declining trees and causes leafspots and discoloration of eucalyptus foliage. Although there is little published on its biology and pathogenicity, it is considered ubiquitous globally, including in California, which suggests the fungus likely has an endophytic phase.

Re-flushing eucalyptus trees at Albany Hill Park (Alameda County) in April. These trees showed significant dieback in 2020. Photos by: S. Frankel, USDA Forest Service

The collapse or degradation of tree health in both the acacia and eucalyptus was associated with low precipitation levels and high evaporative demand in the region due to heat waves, reduced fog, and extended drought in 2020. Those conditions moderated in 2022 and trees appeared to be recovering. The mechanisms causing the damage have not been comprehensively determined, but preliminary measurements and weather patterns indicate that heat and drought stress triggered expanded colonization by endophytic fungi. Many tree and shrub species were impacted with each displaying a different pattern of decline due to the tree species' physiological response to drought and heat, as well as several associated agents - insects or fungi triggered by stress. Recovering trees were commonly observed around Albany Hill Park, Lake Chabot Regional Park, San Leandro Reservoir, Joaquin Miller Park, and throughout Oakland; Tilden Regional Park and other parts of Berkeley (Alameda County); Mt Diablo State Park and throughout Richmond (Contra Costa County); and many other areas throughout the Bay Area.

Browning and dieback of several manzanita species (*Arctostaphylus* spp.) became evident at Mt. Diablo (Contra Costa County) starting in early 2021. Affected species included common manzanita (*A. manzanita*), Mt. Diablo manzanita (*A. auriculata*), and bigberry manzanita (*A. glauca*). Early in the development of browning and dieback, some entire plants appeared dead, but closer observation usually revealed the presence of green tissue in most branches. Often only the tip-most leaves were brown, with leaves in the inner crown still green. The fungus *Neofusicoccum australe*, which is ubiquitous on manzanita species as well

as various other plant species throughout California, was isolated from twig cankers. Climatic analysis of the years preceding the dieback symptoms pointed to an extreme heat event as well as an accumulating water deficit from 2019-2021 as potential important contributing factors to the manzanita dieback. Extremely high maximum daily and minimum nightly temperatures, with highs being up to or above 110°F and overnight lows in the upper 60s and lower 70s, occurred August 14-20 and September 5-7, 2020. These temperatures may have directly injured leaf tissues, growing tips, and green woody tissues in twigs and small branches. In addition to the direct heat injury, a precipitation deficit accumulated at Mt. Diablo in the 2020-2021 and 2021-2022 water years likely limited the ability of plants to repair injured tissues and defend against fungal expansion. Nevertheless, although some shrubs died, by 2022 new foliation was evident on many.

Stand-scale knobcone pine mortality began to appear at the same time as manzanita browning became evident at Mt. Diablo. Although the pine mortality was ultimately caused by an outbreak of California five-spined Ips, the same abiotic factors that underlay the manzanita symptoms and mortality (extreme heat events and long-term precipitation deficit) probably also served as factors for this outbreak. However, there were two additional factors underlying this scenario. First, high heat during summer, particularly in 2020, may have reduced fog intrusion into the landscape at Mt. Diablo, depriving the knobcone pines of a significant source of supplemental water. Second, in late 2018 large-scale tree-cutting for power transmission line clearance created large amounts of knobcone pine slash. It is well documented that slash deposits serve as breeding grounds for all pine engraver beetle species. It is likely that the slash created in 2018 jumpstarted a landscape-level increase in beetle populations that played a dominant role in knobcone pine mortality starting in 2020.

Coast Redwood Branch Fall

At Pamplin Grove and Van Duzen County Park in Humboldt County, an unusual number of large redwood branches fell from tree crowns in summer 2022. A total of ten notable falls occurred (six at Pamplin Grove, four at Van Duzen County Park), with eight of them occurring during the late afternoon on calm days with no fog. All the branches were fully green (living), and only one had any visible decay in any part. Most branches fell from upper parts of the tree crowns, and they all broke a short distance from the tree trunk, leaving a short protruding branch spur. The cause of these branch falls is unknown, but some of them caused damage to camper and park property.

Ponderosa Pine Needle Loss

Along the Highway 101 corridor from Ukiah to Laytonville in Mendocino County, browning of second year and older ponderosa pine needles was ubiquitous in late summer and early fall 2022, causing the stands to look heavily damaged even though current-year needles were still green. The dramatic change in coloration was attributed to severe water deficits.

Ponderosa pine stand discoloration attributed to mortality of the older needle cohort along Highway 101 north of Laytonville (Mendocino County).
Photo by: C. Lee, CAL FIRE

Unknown Oak Damage

Oozing resin was observed on ~12 live oaks in Amador, El Dorado, and Calaveras Counties this summer. All the trees died, but insect or pathogen activity was not confirmed as the cause of resin flux or tree mortality. Western oak bark beetle (*Pseudopityopthorus pubipennis*) emerged from some cuttings taken from a sample, but there was no evidence that a mass-attack caused the mortality. These trees were likely already in severe decline from prolonged drought stress and that attracted insects.

Squirrel damage on cones of Jeffrey pine.
Photo by: M. MacKenzie, USDA Forest Service

Close-up of squirrel damage on Jeffrey pine.
Photo by: M. MacKenzie, USDA Forest Service

Squirrels (unknown species)
Several Jeffrey pines around Carson Pass (El Dorado County) had squirrel feeding damage on their cones. A tree squirrel was observed in the crown of trees. Feeding appeared to damage just one side of the cones and leave the other side largely untouched. This habit is different from what is normally seen in seed orchards where the squirrels tend to clip off a cone and eat it all leaving just the cone center.

Unknown Animal
A high elevation inventory crew reported foxtail pines with damaged crowns and branch dieback in the forests near Chicken Springs Lake in Golden Trout Wilderness (Inyo County). Further investigation by FHP staff determined that branch and terminal dieback was caused by animal feeding on the live cambium causing the crown to be girdled. Dead branches remained on the trees. Some trees appeared to have been targeted by multiple animals. Other trees were undamaged. Further investigation is needed to determine which animal caused the damage and why there were multiple feeding attacks on individual trees. Similar feeding damage caused by an unknown animal was even more prevalent in whitebark pine stems found on Minaret Summit (Inyo NF, Mono County).

Close-up of unknown animal feeding on foxtail pine.
Photo by: M. MacKenzie, USDA Forest Service

Close-up of squirrel damage on Jeffrey pine.
Photo by: M. MacKenzie, USDA Forest Service

USDA Forest Service funding to the Agricultural Research Service (ARS) and CDFA supported ongoing projects for biocontrol of invasive forest plants. ARS & CDFA worked together to continue rearing and releasing the rosette weevil (*Ceratapion basicorne*) to control yellow starthistle (YST) (*Centaurea solstitialis*), a prolific seeder that prevents the establishment of other species. The insect feeds on rosette leaves and lays eggs inside the leaves. Larvae feed inside the upper root, and pupation occurs inside the plant.

The project's first release of the weevil in the field was in 2021, followed by a successful infestation and initial cycle of reproduction in the field. 38 weevils were released at Fort Hunter-Liggett (Monterey County) in collaboration with the Department of Defense in March, 2022. A follow-up survey in June suggested successful reproduction (5% of 100 plants were attacked), pending confirmation that weevils caused the damage, via genetic fingerprinting. Data on plant populations and attack rate by seed-head insects was also collected in August for long-term monitoring of the impact of the rosette weevil.

In 2022, principal ARS investigators completed training of scientists at CDFA's Biological Control Program laboratory in development of mass rearing of insect release agents on YST and puncturevine (*Tribulus terrestris*). CDFA labs received 43 adult weevils from the ARS project. Weevils are being acclimated in order to induce egg laying in January/ February of 2023. Collection and holding of weevil-infested puncturevine was completed for locations in the Central Valley and northern California, confirming establishment of both agents throughout this region. Funding also continues to support work on monitoring of Cape ivy (*Delairea odorata*) biocontrol agents on the central coast in partnership with UC-Santa Barbara.

Close-up of the rosette weevil. Photo by: L. Smith, USDA-ARS

Damage to starthistle leaves caused by rosette weevil.
Photo by: I. Wibawa, USDA-ARS

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The California Forest Pest Council (CFPC), a 501(c)(3) non-profit organization, was founded in 1951 as the California Forest Pest Control Action Council. Membership is open to public and private forest managers, foresters, silviculturists, entomologists, plant pathologists, biologists, and others interested in the protection of California's urban and wildland forests from injury caused by biotic and abiotic agents. The Council's objectives are to establish, maintain, and improve communication among individuals who are concerned with these issues. These objectives are accomplished by:

1. Coordinating the detection, reporting, and compilation of pest injury, primarily from forest insects, diseases, and animal damage.
2. Evaluating pest conditions, primarily those of forest insects, diseases, and animal damage.
3. Making recommendations on pest control to forest managers, protection agencies, and forest landowners.
4. Reviewing policy, legal, and research aspects of forest pest management and submitting recommendations to appropriate authorities.
5. Fostering educational work on forest pests and forest health.

The California Board of Forestry and Fire Protection recognizes the Council as an advisory body in forest health protection, maintenance, and enhancement issues. The Council is a participating member in the Western Forest Pest Committee of the Western Forestry and Conservation Association.

This report was prepared by Forest Health Protection, US Forest Service, Pacific Southwest Region and the California Department of Forestry and Fire Protection with other member organizations of the Council.

2022 Field Tours: Weed Tour, Mt. Shasta, June 28-29; Insect & Disease Tour, Mt. Shasta, June 30; and Henry Cowell Redwoods State Park: Old Growth Redwood Tour, Santa Cruz, July 2.

2022 Annual Meeting: November 16-17, UC Davis, virtual option

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