California Forest Pest Conditions

2021

A publication of the
California Forest Pest Council

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Cover photo:

Landscape view of lodgepole needleminer damage, looking south to Rafferty Creek, Yosemite National Park.
Photo Credit: B. Bulaon, USFS

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Remote Sensing Survey	
Acres aerially surveyed 2021:	38 million acres
Acres virtually surveyed 2020:	4 million acres

The USDA Forest Service, Pacific Southwest Region, State and Private Forestry staff conducts annual aerial surveys throughout forested areas of California to detect recent tree mortality, defoliation, and other damage. Aerial Detection Surveys (ADS) are flown in a small, fixed-wing aircraft on a 4-5 mile grid pattern with 2 observers recording from opposite sides of the plane. Most National Forests and Parks in California are surveyed, along with other federal, state, and private forested lands.

For the 2021 flight season, approximately 38 million acres were surveyed between July and October. Due to multiple wildfires that burned from several days to months, several areas were not covered by normal aerial survey operations. In addition, areas that burned in the 2019 and 2020 fire seasons were largely not surveyed.

Some of the areas not flown in the 2021 aerial survey were instead observed with "scan and sketch" methods developed during 2020 when flights did not occur due to COVID travel restrictions. Approximately 146,000 acres of the the Shasta-Trinity National Forest (NF) were scanned. These areas of interest were virtually surveyed by 3 surveyors utilizing tablets to visually scan satellite imagery and digitize points and polygons of disturbance. The imagery acquisition date was September 23, 2021. Additionally, a special request for "Scan and Sketch" to cover the East Bay mortality event in early 2021 was carried out over 82,000 acres by 1 surveyor. Imagery acquisition dates were between August 15 and October 6, 2020. Images collected by the WorldView-2, WorldView-3, and GeoEye-1 satellites, pansharpened to 30-50 cm resolution, were acquired from Maxar Technologies under the U.S. Government's EnhancedView Program. The tree damage observed from scan and sketch methods is included in totals below.

USFS Aerial Detection Survey, California, 2021. Map by: M. Woods, USFS

Elevated levels of tree mortality were recorded on approximately 1.3 million acres, totaling an estimated 9.5 million dead trees, mostly fir, followed by ponderosa pine. Most of the mortality can likely be attributed to the lingering effects of the 2012-2016 exceptional drought and subsequent successful bark and engraver beetle attacks that have now resulted in ~173 million dead trees since 2010, along with effects from the more recent drought beginning in 2020.

Since ADS was not conducted in 2020 (see the 2020 CA Forest Pest conditions report for more information), trends in mortality will be discussed below by comparing 2021 to 2019 data.

The numbers of acres and trees below are rounded as appropriate. Acres reported below may be noted in more than one bullet, as multiple damaging agents often occur in the same location. Additionally, not all host trees in any given acre were killed or damaged.

Bark Beetles and Wood Borers

- California/Shasta red fir (*Abies magnifica*), white fir (*Abies concolor*) and grand fir (*Abies grandis*) comprised over 64% of the tree mortality recorded in 2021. Approximately 6.1 million dead firs were recorded across ~780,000 acres, compared to ~12.4 million dead firs across ~1.9 million acres recorded in 2019.
- Pine mortality attributed to western pine beetle (*Dendroctonus brevicomis*) increased from an estimated 790,000 dead trees across 124,000 acres in 2019 to ~2.1 million dead trees across 300,000 acres in 2021.
- 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 ~550,000 dead trees across 57,000 acres in 2019.
- 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 ~280,000 dead trees across 32,000 acres in 2021 from approximately

270,000 dead trees across 29,000 acres in 2019. Mortality was particularly severe and widespread in higher elevations of the southern Sierra Nevada range.

- Jeffrey pine (*Pinus jeffreyi*) mortality attributable to Jeffrey pine beetle (*Dendroctonus jeffreyi* or *Ips* sp.) decreased to 31,000 acres and ~130,000 dead trees, compared to 70,000 acres and ~190,000 dead trees in 2019.
- Goldspotted oak borer (*Agrilus auroguttatus*)-related oak mortality, mostly in San Diego County, increased to ~19,000 dead trees across 4,000 acres from ~17,000 dead trees recorded across 11,000 acres in 2019. Three concentrated areas of high-severity goldspotted oak borer mortality near the Palomar Ranger District and Lake Henshaw accounted for over half of the total tree mortality recorded in 2021, resulting in lower total acres of mortality when compared to 2019.
- Douglas-fir (*Psuedotsuga menziesii*) mortality (not attributed to damage by bears) remained elevated in 2021 with an estimated 170,000 dead trees across 18,000 acres, compared to ~130,000 dead trees across 27,000 acres in 2019.
- Pinyon pine (*Pinus monophylla*) mortality attributed to *Ips* sp. increased from an estimated 5,600 dead trees across 10,000 acres in 2019 to 60,000 dead trees across 8,400 acres in 2021. Mortality was concentrated primarily in the White Mountains in both Inyo and Mono Counties.

Pockets of often intense white fir mortality were common along and east of the crest of the Warner Mountains, Modoc NF, Modoc County.
Photo by: J. Moore, USFS

Ongoing severe whitebark pine mortality Near Glass Creek Meadow, Inyo NF, Mono County. Photo by: N. Stevens, USFS

Defoliation

- Defoliation of quaking aspen (*Populus tremuloides*), typically attributed to Marssonina leaf blight (*Marssonina* spp.), was observed on only 500 acres in Mono County, by far the lowest in recent years.
- Defoliation of pinyon pine (*Pinus monophylla*) was observed on approximately 1,800 acres in the White Mountains, Inyo NF attributed to pinyon needle scale (*Matsucoccus acalyptus*).
- Severe defoliation of lodgepole pine (*Pinus contorta*) by lodgepole pine needleminer (*Coleotechnites milleri*) was recorded on approximately 8,500 acres, down from ~12,000 acres recorded in 2019 and again was concentrated in and around Yosemite National Park.
- Severe defoliation of Sitka spruce (*Picea sitchensis*) due to spruce aphid (*Elatobium abietinum*) was detected on approximately 60 acres, down from 1,300 acres recorded in 2019.

Group oak mortality along the Mendenhall Valley near Palomar Mountain, likely due to GSOB, Cleveland NF, San Diego County. Photo by: J. Moore, USFS

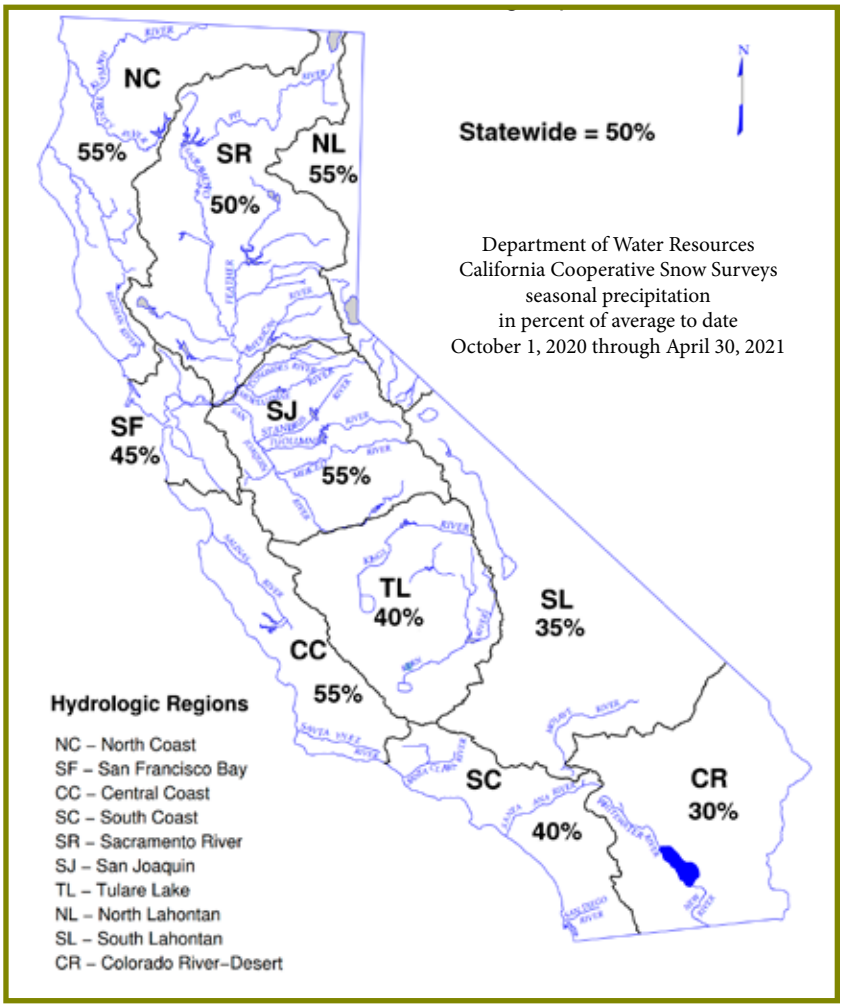
Diseases

- Tanoak (*Notholithocarpus densiflorus*) mortality attributed to sudden oak death (*Phytophthora ramorum*) decreased to an estimated 97,000 dead oak trees across 16,000 acres compared to ~890,000 dead trees across 92,000 acres in 2019.

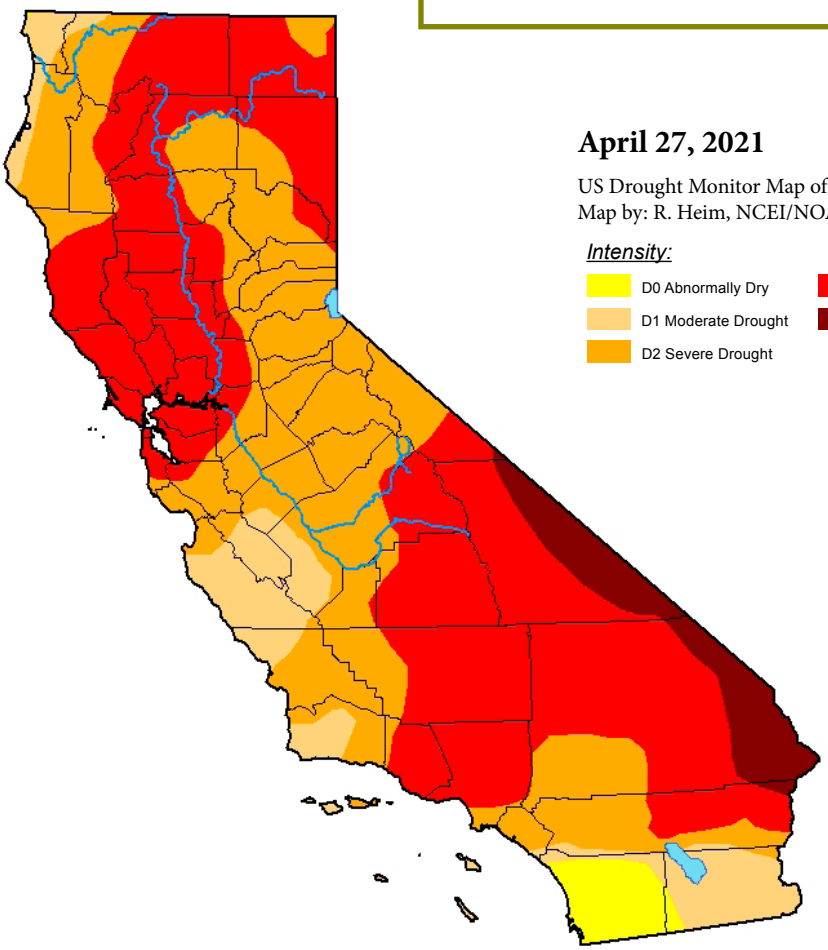
Drought

Suspected oak mortality was observed in many areas, especially the foothills of the southern Sierra Nevada range; however, it is not possible via ADS to determine if the trees were dead or exhibiting an early leaf drop drought response. ADS did detect ~75,000 dead hardwood trees across 3,700 acres, particularly acacia (*Acacia* spp.) and eucalyptus (*Eucalyptus* spp.), in the East Bay (Alameda and Contra Costa Counties). Gray pine (*Pinus sabiniana*) mortality increased from an estimated 750 dead trees across 30 acres in 2019 to 53,000 dead trees across 4,200 acres in 2021.

Statewide precipitation in percent of average to date from October 2020 - April 2021 was 50%, compared to 70% for the same time period in 2019 - 2020. Northern California forested area rainfall totals were 50 - 55% of average, and Southern California areas were 30 - 40% of average (see map on right). The 2020 – 2021 water year (water year is from October 1 – September 30) was the 3rd driest on record (since January 1895). Precipitation was slightly above average in July, while October and May were the 2nd driest ever recorded (1.15" and 0.77" below average, respectively). April was also abnormally dry. Every other month was dryer than normal but not record setting. 2021 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 – 2019). While November and March temperatures were normal, October, June, and July were the warmest on record (6.7°F, 6.6°F, and 5.2°F above their monthly averages, respectively). April, August, and September were also abnormally warm but not record setting. The 2021 water year was the 2nd warmest on record; the average annual temperature across California was 3.4°F above the historical average (https://www.ncdc.noaa.gov/cag/statewide/rankings).



April 27, 2021

US Drought Monitor Map of California
Map by: R. Heim, NCEI/NOAA

Intensity:

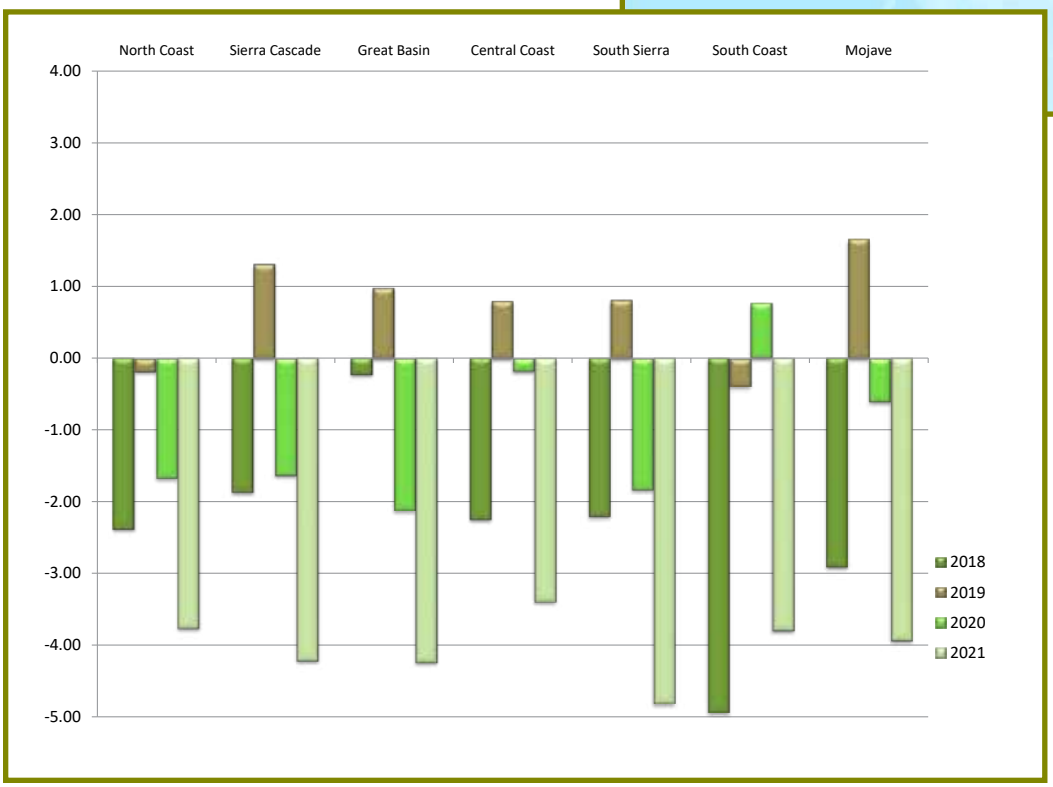
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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 2020 – 2021 water year, the yearly average PDSI values ranged from -3.4 in the Central Coast (least dry zone) to -4.81 in the South Sierra (driest zone) (see map). The entire state of California was in severe to extreme drought conditions through September 30, 2021.

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

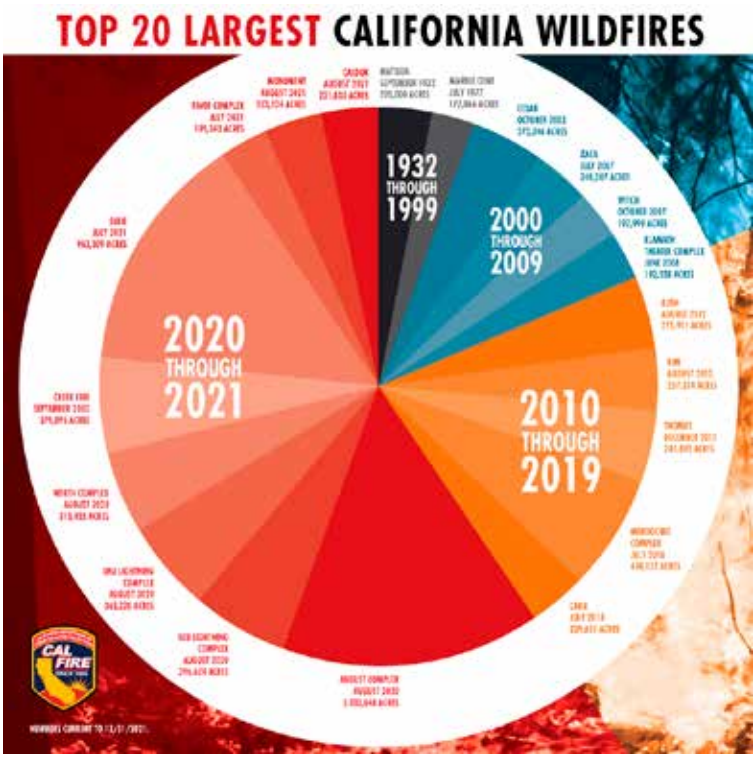
Palmer Drought Severity Index (PDSI) for California, 2018 - 2021



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

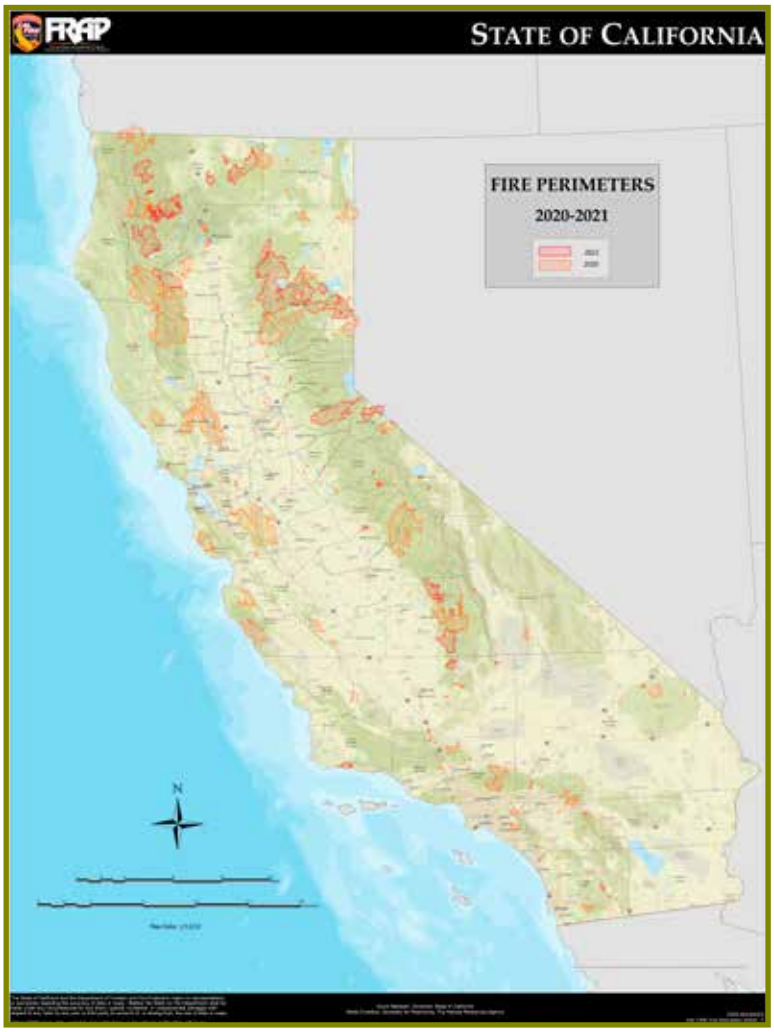
Palmer Classifications

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



Top 20 Largest California Wildfires. Infographic by: California Forest Management Task Force, https://fmtf.fire.ca.gov/media/cjwfpckz/californiawildfireandforestresilienceactionplan.pdf

The greatest impact on tree mortality in 2021 was from wildfires. According to the California Department of Forestry and Fire Protection (CAL FIRE), there were 8,835 incidents of wildfire covering a total of 2,568,948 acres. This is the second straight year of multiple record-setting fires in California and a second year of worsening statewide drought conditions. The damage in 2021 included the loss of over 3,600 structures, three fatalities, and mortality or damage to an unknown number of trees. Six fires were over 100,000 acres in size, including the Dixie Fire (963,309 acres in Butte, Plumas, Shasta, Lassen and Tehama Counties), the second-largest recorded wildfire in California state history. Other counties that were heavily impacted with large fires in 2021 include: Alpine, Amador, Eldorado, Kern, Mono, Santa Barbara, Siskiyou, Trinity, and Tulare. Many of these counties were also impacted by large 2020 fires. All fires resulted in direct mortality, and trees that survived are also more susceptible in future years to pests such as bark and engraver beetles, wood borers, and other insects and diseases that take advantage of weakened trees, particularly if drought conditions persist.



California Wildfires, 2020 - 2021. Map by: Fire and Resource Assessment Program (FRAP), CAL FIRE

Fire-damaged trees from the Dixie Fire in northeastern California.
Photo by: S. Smith, USFS

2021 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 2021*, all observations were submitted via the mobile data entry form and supplement the Aerial Detection Survey data (see page 2). This map shows the locations of pest observations made by forest health professionals in 2021. The most frequently reported damage-causing agent was western pine beetle, followed by mountain pine beetle, Armillaria root disease, and true mistletoe. The most frequently reported host species was ponderosa pine, followed by Jeffrey pine and California live oak.

* Observations in 2021 were limited due to statewide COVID-19 related travel restrictions.

NOTE: Field observations were limited during 2021 due to the COVID-19 pandemic that resulted in stay-at-home orders limiting travel and field work.

Native Insects

Bark Beetles

Western Pine Beetle (*Dendroctonus brevicomis*)

Western pine beetle-caused mortality appeared to be above background levels at lower-elevation (<4,000 ft) dry sites. Several 5- to 20-tree groups of ponderosa pine (*Pinus ponderosa*) were killed along the shoreline of Shasta Lake, Shasta-Trinity NF (Shasta County). In lakeside campgrounds, the Shasta-Trinity NF recreation staff have continued cutting dead ponderosa pine hazard trees that were killed by western pine beetle.

Widespread western pine beetle-caused mortality of ponderosa pine was observed northeast of Foresthill within the Tahoe NF (Placer County). At least 150 mortality pockets ranging from approximately 10 to 100 trees were distributed across approximately 10,000 acres of 60-year-old plantations. Drought and overstocking, as well as fire-injury in some locations, are all contributing to tree stress and susceptibility to bark beetle attacks.

Several large groups (>20 trees) of dead ponderosa pine were observed above Lake Oroville (Butte County) on private residential land along Highway 70.

Throughout 2021, the population of western pine beetle increased throughout the lower ranges of the Sierra Nevada, attacking and killing ponderosa pine. Levels were still less than during the previous epidemic years but are increasing. Trees were so stressed from ongoing drought conditions that many were unable to produce pitch tubes in defense against the bark beetles. Small spot infestations of around ¼ acre each were particularly evident in Placer, Mariposa, and Madera Counties. The Mariposa and Madera County sites expanded from small areas of windthrow that occurred during major storm events that occurred in mid-January.

Groups of trees infested with western pine beetle have been observed throughout southern Sierra Nevada forests. Reports came later in the season, as ponderosa pines began changing colors in groups, most noticeably along Highway 41 north towards Yosemite National Park and along Sky Ranch Road, Bass Lake Ranger District (Madera County).

Low levels of pine mortality associated with western pine beetle and Jeffrey pine beetle continued to occur throughout the San Bernardino Mountains, typically as individual trees or in isolated pockets of 3 to 10 trees. Affected species include ponderosa and Jeffrey (*Pinus jeffreyi*) pines.

Jeffrey Pine Beetle (*Dendroctonus jeffreyi*)

In the Bear Valley Springs area of Tehachapi in Kern County, Jeffrey pines were dying as a result of increased drought stress and impacts from Jeffrey pine beetle, red turpentine beetle (*Dendroctonus valens*) and California flatheaded borer (*Phaenops californica*). Mortality reported on the east side of Bear Mountain was approximately 10% of the stands, while the stands on the west side of the south slope of Bear Mountain were experiencing 20 to 30% mortality.

Low levels of Jeffrey pine mortality (<1 tree/acre) occurred across the Mountaintop Ranger District of the San Bernardino NF (San Bernardino County). Most of the tree mortality was sporadic, with single dead trees scattered over large areas.

Recent and old Jeffrey pine mortality on the San Bernardino NF, looking northwest from Hwy 38 near Barton Flats, San Bernardino County.
Photo by: S. Hishinuma, USFS

Mountain Pine Beetle (*Dendroctonus ponderosae*)

Mountain pine beetle-caused mortality of whitebark pine (*Pinus albicaulis*) was noted on single trees and pockets of 5 to 10 trees on Goosenest Mountain on the Klamath NF (Siskiyou County) in 2020 and 2021.

Mountain pine beetle-caused mortality of lodgepole pine (*Pinus contorta*) continued in the Medicine Lake caldera, Modoc NF (Siskiyou County). Mortality occurred in groups (3 to 20 trees) and single trees across approximately 1,000 acres. Verbenone applications and infested tree removal were implemented to minimize mortality in campgrounds and day use areas.

Increased lodgepole pine mortality was observed near Donner Summit, Tahoe NF (Placer and Nevada Counties). Mountain pine beetle-killed trees were mostly single trees and small groups (<5 trees) over approximately 1,500 acres.

Red Turpentine Beetle (*Dendroctonus valens*)
Red turpentine beetle attacks on ponderosa pine were found throughout central California from Plumas to Kern County. Although usually only an individual tree was found, some small groups of up to a dozen trees were attacked. The attacks were unusual, often killing trees and extending from the base up to twenty feet or more on the bole. The severe drought conditions were thought to be the cause of this change in beetle behavior.


Entire stands were damaged by high winds along Highway 88. Photo by: B. Bulaon, USFS

Fir Engraver (*Scolytus ventralis*)
White fir (*Abies concolor*) mortality increased in the south Warner Mountains, Modoc NF (Modoc County). Mortality was most associated with fir engraver beetle attacks in overstocked low-elevation stands scattered at approximately 2 to 5 trees per acre over at least 10,000 acres. These stands were historically pine-dominated, but fire exclusion has allowed white fir to become established over the past 150 years. These stands have experienced several engraver fir engraver outbreaks associated with drought over the past 30 years.

Mortality and damage due to fir engraver in true firs continued in the southern Sierra Nevada, likely due to very high summer temperatures and prolonged drought. Fir engraver activity was also heightened due to several major disturbance events from recent years. Severe windstorms caused blowdown of multiple groups of red fir (*Abies magnifica*) along Highway 88 northeast of Foster Meadows (Eldorado and Amador Counties). Engraver dust lined the boles of about ten >20-inch red firs that were completely uprooted. Engravers did not move to standing live trees but remained in the green fallen or broken stems.


Understory white fir mortality in the Jenks Lake area on the San Bernardino NF, San Bernardino County. Photo by: S. Hishinuma, USFS

In the 2020 Creek Fire (Madera County, Bass Lake RD, Sierra NF), fir engraver boring dust was mingled with ambrosia beetle dust on fire-injured trees, primarily in locations with moderate burn severity. Fir engravers targeted mostly larger-diameter trees, and some crowns were already fading upon inspection this summer.

White fir mortality continued in the Barton Flats area (San Bernardino NF, San Bernardino County) west of Hathaway Flat and south of Jenks Lake. Overstory fir mortality was low (3 to 4 trees/acre) near Jenks Lake, but understory mortality was higher, approaching 8 trees/acre close to the lake.


White fir mortality surrounding Jenks Lake on the San Bernardino NF, San Bernardino County. Photo by: S. Hishinuma, USFS

Flatheaded Fir Borer (*Phaenops drummondi*)
Scattered Douglas-fir mortality was observed at several low-elevation sites along the west slope of the Sierra Nevada within the Lassen and Plumas NFs (Tehama, Butte, and Yuba Counties) and adjacent private lands. Most tree mortality occurred in single larger-diameter trees (>20 inch DBH (diameter at breast height)) scattered across several thousand acres of poor-quality growing sites.

Ips Engraver Beetles (*Ips* spp.)
Numerous stands and individual ponderosa pine trees were killed directly by ips beetles throughout the Sierra Nevada region of central California. Tree were often scattered or in small groups. Pitch tubes were rarely formed due to the drought stress experienced by the trees.

Pinyon Ips (*Ips confusus*)
Pinyon ips mortality occurred near Gocke Valley (San Bernardino NF, San Bernardino County) east of Big Bear Lake. Mortality was low over a 200-acre area (1 to 2 trees/acre), but higher near the residential areas (4 to 5 trees/acre).

Pinyon pine mortality near residential areas east of Big Bear Lake, San Bernardino NF, San Bernardino County. Photo by: S. Hishinuma, USFS

Ambrosia Beetles
Ambrosia beetle attacks are increasing in both post-fire and non-burned areas in the southern Sierra Nevada. *Platypus wilsoni* is most notable in true firs burned in 2020 and 2021 in Sierra, Sequoia, and Eldorado NFs (Madera, Kern, and Calaveras Counties). In the 2020 Creek Fire near Whiskey Falls Campground (Madera County), eight fir trees within an acre patch with severe bole scorch were covered with *P. wilsoni*'s distinctive boring dust. Trees without burn scars but located in the same high-intensity burned sites were also mass attacked. Attacked true firs were mostly in the larger diameter classes (>20 inches).

Similar to 2020, Jeffrey and lodgepole pines attacked by *Dendroctonus* species were also attacked by ambrosia beetles. Even though trees still had green crowns, ambrosia boring dust covered the bases of at least 20 newly killed Jeffrey pines at the Inyo Craters Trailhead (Mono County). Further west along 3S89 road six lodgepole pines recently killed by mountain pine beetle (average DBH of 14 inches) had the distinctive white boring dust of ambrosia beetles at their bases.

Profuse ambrosia beetle boring dust at the base of a fire-killed white fir in the Creek Fire, Sierra NF. Photo by: B. Bulaon, USFS

Cedar Bark Beetles
(*Phloeosinus* spp.)
A wind event that caused several giant sequoias to fall in the Mariposa Grove, Yosemite National Park (Mariposa County), also caused a tremendous number of large green limbs to fall from standing sequoias (*Sequoiadendron giganteum*). These limbs were promptly infested by cedar bark beetles, but they did not infest the larger blowdowns.

Cedar bark beetle activity increased on moderate- to severely- burned trees from wildfires and prescribed burns that occurred in 2020. At Calaveras Big Trees State Park (Calaveras County), at least 10 large incense-cedars (*Calocedrus decurrens*) injured by 2020 prescribed fire were attacked by cedar bark beetles. In the 2020 Creek Fire (Madera County), a

Heavy accumulation of ambrosia beetle boring dust at the base of a recently attacked Jeffrey pine.
Photo by: B. Bulaon, USFS

Ambrosia beetles found infesting live white fir in the Creek Fire, Sierra NF. Photo by: B. Bulaon, USFS

2 acre burn, that was assessed to be of low-to moderate-severity, five incense-cedars were attacked by cedar bark beetle. This beetle is historically rare on larger standing trees but is generally appearing more frequently.

A cedar bark beetle infestation in all size classes at Calaveras Big Trees State Park and surrounding areas caused extensive branch tip death (flagging) throughout tree crowns. Sampling of flagged branches revealed two species, *Phloeosinus vandykei* and *P. punctatus*. Whole tree mortality was rare.

Western Oak Bark Beetle
(*Pseudopityophthorus pubipennis*)
See Diseases – Foamy Bark Canker

Oak Twig Girdler (*Agrilus angelicus*)
The oak twig girdler has been found significantly increasing on coast live oak throughout San Luis Obispo and Santa Barbara Counties. This girdler caused scattered patches of fading leaves turning to brown leaves throughout the canopy. The larvae mine spirally and girdle the twig causing foliage to die. Drought-weakened oaks are especially prone to twig girdler attack, but this pest usually does not affect tree survival.

Oak twig girdler on coast live oak in San Luis Obispo County.
Photo by: K. Corella, CAL FIRE.

Defoliators

Douglas-fir Tussock Moth
(*Orgyia pseudotsugata*)
Traps set out for monitoring the Douglas-fir tussock moth in Madera and Calaveras Counties recorded no moth catches in 2021. Apparently, populations of the moth are low in these areas.

Heavy lodgepole needleminer damage along Highway 120, Yosemite NP.
Photo by: B. Bulaon, USFS

Lodgepole needleminer
(*Coleotechnites milleri*)
This year has been the first time since the early 1990s that widespread defoliation by the lodgepole needleminer was categorized as “severe.” It was noted along Highway 120 from John Muir Trailhead to Tuolumne Meadow Lodge Road south into Rafferty Creek drainage as well as northeast from Lambert Dome up to Dog Lake (Tuolumne County).

Ground surveys of affected roadside trees found the first two needle whorls and entire crowns to be damaged, regardless of size. Trees in the smaller (<5 inch) diameter class had all needle whorls affected.

Landscape view of lodgepole needleminer damage, looking south to Rafferty Creek, Yosemite NP. Photo by: B. Bulaon, USFS

Lodgepole needleminer damage, looking east into Dog Lake, Yosemite, NP.
Photo by: B. Bulaon, USFS

Close up of lodgepole needleminer feeding damage on lodgepole pine along Tioga Pass, Yosemite NP. Photo by: B. Bulaon, USFS

Pinyon pine stand with severe pinyon needle scale infestation, Inyo NF.
Photo by: B. Bulaon, USFS

Close up of severe damage caused by pinyon needle scale, Inyo NF.
Photo by: B. Bulaon, USFS

Pinyon Needle Scale (*Matsucoccus acalyptus*)
Damage from pinyon needle scale continues to intensify on trees previously infested in the southern portions of the White Mountain Range, Inyo NF (Mono County). Although no tree mortality was observed, about 30% of trees in affected areas continue to be defoliated. The most severe defoliation was observed in the areas of Cedar Flat Group Camp and patches along the White Mountain Road below 7,500 feet elevation. Severe defoliation was as high as 100%, with many trees having already dropped needles. Scale appears to be moving into adjacent trees and dispersing outward.

Yucca Scale (*Situlaspis yuccae*)
About an acre of palo verde trees (*Parkinsonia* spp.) were being affected by yucca scale at Rancho Mirage and Mecca in Riverside County. This small, armored scale can be found along the trunk and up into the crown on minor twigs. The symptoms observed were cankers and canopy die-back starting at the small branches and, ultimately, tree decline. These locations and insects will be monitored to determine spread and if symptoms continue or cause lasting damage.

Palo verde crown die-back from yucca scale.
Photo by: T. Takeuchi, Cal Poly Pomona

Yucca scale on palo verde trunk.
Photo by: T. Takeuchi, Cal Poly Pomona

Pine Tortoise Scale (*Toumeyella parvicornis*)
A single Italian stone pine (*Pinus pinea*) was found to be infested by pine tortoise scale in Del Mar, just north of Torrey Pine State Reserve (San Diego County). This is a new County and State record for this species and possibly the first record west of the Rocky Mountains. Pine tortoise scale is a soft scale insect with a wide host range and is most often found on 1- and 2-year-old shoots of "hard" pines. These insects can increase stress to the trees from feeding damage and reduced photosynthetic activity due to sooty mold growth and cause reduced tree growth. Heavy infestations can kill individual branches or whole trees.

California Oakworm
(*Phryganidia californica*)
Approximately 500 acres of coast live oak trees were severely defoliated by California oakworm during July on the east side of Highway 101 in Orcutt (San Luis Obispo County). California oakworm typically have two generations per year, but in warmer sites a third generation is possible. Since defoliating outbreaks usually last 1 to 2 years, oak-worm defoliations rarely severely harm or kill healthy trees.


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

Invasive Insects

Goldspotted Oak Borer (GSOB)
(*Agrilus auroguttatus*)
www.gsob.org

Los Angeles County
Los Angeles County Fire in Green Valley has removed 60 GSOB-infested trees and surveyed over 7,700 trees. The detailed survey information is displayed on a public view web map at http://lacounty.maps.arcgis.com/apps/opsdashboard/index.html#/c8b5762089874127819eaabc8eb25218.

Orange County
University of California Division of Agriculture and Natural Resources (UCANR) positively identified two new GSOB infestations on coast live oaks (*Quercus agrifolia*) at the Oak Canyon Nature Preserve and Deer Canyon Park in Anaheim. The infestation in Oak Canyon Nature Preserve is large, with 15 amplifier trees found. It is estimated that GSOB has been in this area for 5 to 7 years based on the level of tree mortality and number of infested trees. Every coast live oak has been surveyed and rated for GSOB and has been GPS located and tagged. Treatments were scheduled for spring 2022 with the amplifier trees planned to be removed. The infestation at Deer Canyon Park is smaller than the infestation at Oak Canyon Nature Preserve.

Irvine Ranch Conservancy staff surveyed 513 coast live oak trees in Weir and Gypsum Canyons from fall 2020 through spring 2021. Approximately 96% of the known infested trees exhibited no new exit holes, due primarily to past carbaryl treatments, and only one previously uninfested tree had signs of a new GSOB infestation. With support from Orange County Fire Authority, 3,250 coast live oak trees were treated with carbaryl in mid-April 2021. Treatment was expanded west down Weir Canyon Road and further south along Upper Blind Road, which effectively increased the buffer area surrounding the most heavily infested areas. Annual monitoring of GSOB will continue.

Orange County Fire Authority assisted to treat approximately 2,750 GSOB-infested coast live oaks at Weir Canyon, 258 coast live oaks in Gypsum Canyon and 650 coast live oaks at Trabuco Canyon.

Riverside County
A Cal Fire-Riverside Unit identified in a survey that 68 black oak (*Quercus kelloggii*) trees were infested with GSOB in the community of Idyllwild and one was infested in Mountain Center. The location and data from all the surveyed trees have been compiled through the Riverside County Dead, Dying and Diseased Tree grant program.

UC Riverside scientists conducting heat treatment research on GSOB-infested oak firewood are testing the efficacy of the heating schedule, known as T314-a, that specifies heating the firewood core to a temperature of 60 °C for 60 minutes to achieve sterilization (insect kill). To ensure the heat treatment is the variable which causes the wood to be insect free, heat-treated firewood was kept alongside untreated firewood that acted as a control. GSOB-infested oak tree wood was split into firewood and either heat treated or placed into a polyvinyl mesh bag to prevent adult beetles that successfully completed pupation from

escaping. Preliminary results suggest the heat treatment may be 98% effective at preventing GSOB emergence from infested firewood. Larger quantities of wood will be tested next year to verify the results from this heat preliminary trial.

Goldspotted oak borer-infested tree at a campground south of Wildwood Canyon State Park, San Bernardino County. Photo by: A. Chacon, IERCD

San Bernardino County

The Wildland Conservancy-run Oak Glen Preserve has seen a significant increase in GSOB, affecting predominately California black oak. The affected area includes the historic Los Rios Rancho and current Oak Glen Preserve and Botanic Garden and has many large oak trees of various species. Since first detection on the Preserve in 2018, GSOB mitigation efforts have been ongoing, including cutting killed trees followed by chipping, injections, and topical pesticide applications. These have met with limited success due to the challenges from infested, unmanaged surroundings. Smaller diameter trees are currently being attacked by GSOB, likely due to the severe impacts on larger trees from the 2020 El Dorado Fire.

The Inland Empire Resource Conservation District (IERCD) is continuing GSOB survey and mitigation work through a Regional Forest and Fire Capacity (RFFC) grant. During surveys of private residences in Oak Glen from November 2020 - March of 2021, 164 black oaks were examined, and 41% (67 trees) were found to be infested with GSOB. Of the 67 infested black oak, seven were identified as heavily infested amplifier trees. With the assistance of the Cal Fire Oak Glen Conservation Camp Tree Crew, these were removed along with six heavily-infested and three moderately-infested trees.

Windshield surveys by IERCD in September 2021 also confirmed the continued presence of GSOB in black oaks in the Big Bear community of Sugarloaf, as well as black oaks in Forest Falls. IERCD confirmed a new GSOB infestation in coast live oaks at the campground south of Wildwood Canyon State Park in Yucaipa. Discussions with landowners regarding surveys and treatments have been initiated.

Cal Fire-San Bernardino Unit found 10 GSOB-infested California black oaks on private properties in the community of Forest Falls.

San Diego County

On the Palomar Ranger District, Cleveland NF, carbaryl was applied for the fifth consecutive year to 256 coast live oak trees across four sites: Oak Grove Campground and Fire Station, Inaja Memorial Picnic Area, and Pine Hills Fire Station near Julian. Yearly monitoring shows that insecticide applications are preventing further impacts to coast live oaks at these sites.

In 2020/2021 an increased number of mature coast live oak trees began to die within the Escondido Creek Preserve infestation, first discovered in 2018/19. Preliminary surveys were performed in summer 2020. Between March and mid-May 2021, a new survey was done outside of the GSOB's emergence and flying season. During the survey, 543 mature coast live oak trees were surveyed, and about 34% were found to be infested. This infestation is expected to expand as managers work towards creating an Integrated Pest Management (IPM) plan.

The Escondido Creek Conservancy and Elfin Forest Recreation Reserve conducted GSOB surveys in riparian zones between March and mid-May 2021. The Elfin Forest Recreation Reserve comprises 784 acres of oak riparian and oak woodland habitat and was found to have 33 coast live oak trees infested with GSOB. The Keithley Preserve, which comprises 905 acres of contiguous habitat including riparian oak woodlands, had at least 186 coast live oaks infested with GSOB.

The La Jolla Band of Luiseño Indians continued to actively manage GSOB, including mitigation by removal of infested trees and application of insecticide to protect lightly infested and uninfested trees. In 2021, over 80 coast live oaks were killed by GSOB in the La Jolla Indian Campground. Cumulative GSOB-caused oak mortality in the campground was estimated to be 400 trees within a 100-acre site. This year, 94 GSOB-killed trees were removed and salvaged for firewood. Nearly 50% of susceptible oak trees

in the campground were estimated to be infested with GSOB, with a 5% annual mortality rate in some areas. In the campground, insecticides were applied to 226 coast live oak trees to prevent further GSOB attack and injury. Tree injury and mortality was also estimated by plot surveys throughout the reservation. In total, an estimated 600 trees killed by GSOB require removal. GSOB tree mortality has been observed to be quite severe along Highway 76 to the east and west of the reservation boundaries. The La Jolla Band of Luiseño Indians has been severely impacted, culturally and financially, by this infestation.

Goldspotted oak borer-infested coast live oaks. Photo by: M. Mayes, Peregrine Environmental Imaging, LLC and USCB Earth Research Institute

Invasive Shot Hole Borers (ISHB) (*Euwallacea* spp.)
http://www.iscc.ca.gov/ishb.html
http://www.ishb.org

Los Angeles County
LA County Agricultural Commissioner/Weights and Measures (ACWM) reported visual confirmation of ISHB in Glendale and surrounding areas to old Topanga Canyon and Malibu with 40 western sycamore (*Platanus racemosa*), four palo verde (*Parkinsonia* sp.), five London plane (*Platanus x hispanica*), one Japanese maple (*Acer palmatum*), one avocado (*Persea americana*), and seven cottonwood (*Populus* spp.) trees, ranging from lightly to heavily infested.

In the same area, the California Department of Food and Agriculture (CDFA) detected 10 western sycamore trees, 13 Fremont cottonwood (*Populus fremontii*), and one California buckeye (*Aesculus californica*) with ISHB infestations ranging from low (1 to 50 entry holes) to severe (>150 with die-back). These infestations were confirmed by pathology and/or DNA analyses.

In Whittier Narrows Recreation Area in 2021, 98 trees were found with severe infestations. Affected tree species included three Chinese elm (*Ulmus parvifolia*), one black locust (*Robinia pseudoacacia*), and three cottonwood (*Populus* spp.). The remaining 91 trees were London plane (*Platanus x hispanica*) and western sycamores (*Platanus racemosa*). These latter two species were most severely infested. Hundreds of older infestations in sycamores were found and had low to heavy infestations levels. ISHB was first discovered in the Whittier Narrows Recreation Area in 2003.

A survey is underway at Devil's Gate Reservoir. To date, a broad range of tree species have been identified as affected by this insect, including black willow (*Salix nigra*), boxelder (*Acer negundo*), cottonwood (*Populus* spp.), and sycamore (*Platanus* spp.). Infestation levels range from low to severe.

To date, Los Angeles County ACWM deployed 2,400 ISHB traps throughout the county in Spring 2021. 591 traps have been identified as positive for ISHB. These results demonstrate the need for further investigation including tree surveys to find and better understand current infestations as well as to predict future infestations in Los Angeles. This initial 2021 ISHB trapping survey will help develop future trapping and tree survey protocols.

Volunteers were trained through the Santa Monica Mountains Resource Conservation District (RCD) to participate in the Ventura and LA County Bad Beetle Watch participatory science iNaturalist project. Participants learned to identify GSOB and ISHB, and how to properly document specific tree and infestation parameters in the online application. The entries and photographs uploaded to the application were carefully examined by forest health professionals to determine if observations were either borer. The corresponding county agricultural commissioner was alerted to possible positive posts and locations. ISHB was identified only in Los Angeles County by volunteers. As a result of this citizen iNaturalist project, two new areas with approximately 60 sycamores were reported to be infested with ISHB near Griffith Park and Agoura Hills.

Orange County
Trapping data indicates that the ISHB population is holding steady, consistent with previous years' finds. University of California Cooperative Extension (UCCE) found ISHB for the first time at Dove Canyon in the Bell Canyon area. Bell Canyon is the main

riparian corridor at the 4,000-acre Audubon Starr Ranch Sanctuary in southeast Orange County. ISHB was found on 1 to 2 western sycamores near the adjacent golf course community, Dove Canyon. Since no amplifier trees were found on Starr Ranch, the team placed ISHB sticky traps in Dove Canyon to locate amplifier trees.

Irvine Ranch Conservancy (IRC) conducted annual ISHB surveys of known infestations in Bommer Canyon, Shady Canyon, Quail Hill, and Buck Gully. Initial findings indicate the level of infestation remains low, and the need for active management is not anticipated at this time. IRC collaborated with partners from the UCANR to install four ISHB traps at strategically identified locations in Bommer Canyon and Shady Canyon. Lures and traps will be replaced monthly by staff and analyzed by UCANR. The purpose of these traps is to inform management decisions by indicating where the beetles are moving and where survey efforts should be prioritized.

Orange County Fire Authority (OCFA) continues to survey, treat, and remove ISHB trees. During the last year in Coto de Casa, Modjeska Canyon, Aliso Viejo, Crystal Cove State Park, Dove Canyon Golf Course, and Rancho Mission Viejo, 1,020 trees were treated, 140 trees were removed, and 74 trees were pruned and treated. Over all treatments, 80% of the trees were western sycamore.

San Bernardino and Riverside Counties

Increased monitoring and trapping in San Bernardino and Riverside Counties show that ISHB has spread farther east into the counties; amplifier trees have been found in both counties.

The IERCD is a government agency 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. In March 2021, IERCD began installing ISHB monitoring traps at strategic locations, primarily along the Santa Ana River near the San Bernardino County and Riverside County border. IERCD staff completed trap installation in June 2021 and continued subsequent trap maintenance over the trapping season (April – November). To date, 98 ISHB monitoring traps were deployed and maintained at strategic locations (riparian corridors as well as in select areas of the San Bernardino NF), and ISHB were identified on 32 of the 98 panel traps. These included new detections in San Bernardino County.

Since April 2021, IERCD staff has conducted visual monitoring of ISHB host trees at parks, riparian areas, and forested areas to detect evidence of ISHB injury and infestation. All data associated with monitoring is recorded in the statewide cloud template and submitted to the UC Statewide IPM Program to be included in a statewide ISHB distribution map. A total of 136 public parks and five trails/riparian areas have been surveyed, detecting 25 new ISHB-infested trees in developed public parks (City of Highland, City of Rancho Cucamonga, Chino, and City of Colton).

Following trapping and visual monitoring operations, a Regional Priority Plan will be developed and shared with project partners, stakeholders, and interested entities to help inform future management decisions and best management practices throughout the extent of the grant period (2020-2024). Additionally, current trapping and visual monitoring will further identify trees severely infested with ISHB that IERCD can remove through grant funding. Furthermore, IERCD will collaborate to acquire access to additional property parcels located adjacent to district boundaries within San Bernardino and Riverside Counties. By intensifying and expanding ISHB survey efforts within the Inland Empire and beyond (foothills of San Bernardino Mountains, Mojave Desert Watershed), this work/project will contribute to identifying current ISHB distribution and inform the development of management strategies in southern California.

San Diego County

ISHB infestations of 8.5 acres at the Center for Natural Lands Management preserve located at Rosemary's Mountain Quarry in Oceanside and 12 acres at the Encinas Creek Preserve in Carlsbad were identified. Hundreds of Goodding's black willow (*Salix gooddingii*), arroyo willow (*Salix lasiolepis*), red willow (*Salix laevigata*) and Fremont cottonwood (*Populus fremontii*) were infested at both locations. Infestations have caused crown die-back and branch dropping, but regrowth is seen throughout the preserves.

San Luis Obispo County

No infestations and no further trap catches have been observed in the county since the one ISHB beetle found in a trap in 2016. Trapping and surveying continues in high-risk locations throughout the county.

Santa Barbara County

Santa Barbara County has found ISHB present as far north as Santa Ynez, where several amplifier trees of boxelder (*Acer negundo*) were found positive for polyphagous SHB. Amplifier trees in the southern portion of the county in Montecito consist of western sycamore (*Platanus racemosa*) that are positive for Kuroshio SHB.

Mediterranean Oak Borer (*Xyleborus monographus*)
https://ucanr.edu/sites/mobpc/

A new infestation of Mediterranean Oak Borer (MOB) was detected in a large-diameter valley oak (*Quercus lobata*) in an industrial area of Cotati (Sonoma County), the first detection west of U.S. Highway 101. The high level of infestation indicates the attack was most likely initiated in 2018 or earlier.

Verbenone Splat trials revealed moderate repellency for 30 days. However, by six weeks repellency was weak; at 11 weeks there is weak evidence of an attractant affect. Dispersal flight height was determined to be up to 25 feet above ground using sticky trap towers, indicating bole application of repellents may have limited efficacy in discouraging initial attack.

Non-Native Insects Unknown in California

Emerald Ash Borer (*Agrilus planipennis*)
CDFA established an exterior quarantine for the emerald ash borer (Section 3288) that went into effect April 9, 2021. No known infestations existed in the State at the time. The external quarantine was developed in response to the ending of the federal emerald ash borer quarantine. The state exterior quarantine regulates wood, including firewood, and nursery stock from emerald ash borer-infested states, which includes most of the eastern United States.

Spotted Lanternfly (*Lycorma delicatula*)
The spotted lanternfly exterior quarantine (Section 3287) went into effect June 28, 2021. It regulates a wide variety of articles and conveyances that have been exposed to the outdoors in spotted lanternfly-infested areas. Spotted lanternfly is currently known to be established in 10 eastern states. There is no federal quarantine, and this state exterior quarantine is protecting California from objects that may have spotted lanternfly egg masses as well as hitchhiking nymphs or adults.

NOTE: Field observations were limited during 2021 due to the COVID-19 pandemic that resulted in stay-at-home orders limiting travel and field work.

Invasive Diseases

Pitch Canker (*Fusarium circinatum*)

Pitch canker was found injuring and killing mature Monterey pines (*Pinus radiata*) in a planted stand on East Bay Municipal Utility District lands in Contra Costa County. The trees were also under stress due to drought, extreme heat conditions, and reduced fog events.

Sudden Oak Death (SOD) (*Phytophthora ramorum*)

North Coast

The EU1 lineage of *Phytophthora ramorum* (the plant pathogen that causes SOD) was officially confirmed in Del Norte County for the first time in 2020. This was the first confirmation in California wildlands of the EU1 strain, which appears to be more aggressive on conifers than the NA1 strain prevalent in infested California forests. The isolates collected from the Del Norte County infestation were genetically consistent with EU1 isolates from Oregon forests, the only state in the U.S. in which this strain was previously found in wildlands. Management activities in Del Norte County, conducted in November-December 2020, consisted of removing infected trees and applying herbicide to remaining root systems to prevent re-sprouting, as well as herbicide treatment of tanoaks (*Notholithocarpus densiflorus*) within a wide radius of the original infestation. The treatment also included removal of herbicide-treated trees likely to pose a hazard to State Route 197 after death.

Also in Del Norte County, in 2021, two SOD-positive tanoaks were identified by polymerase chain reaction (PCR) using two distinct assays (nuclear ITS and mitochondrial Cox I). Both belonged to the EU1 lineage based on Cox I sequence. These samples were located relatively near (within a mile of) the EU1 isolates identified in 2020. Although these two samples could not be cultured, they were strong PCR positives.

Previously, in 2019, a Del Norte County site in Jedediah Smith State Park along Mill Creek south of its confluence with the main stem Smith River tested positive as part of a UC Berkeley-led SOD Blitz. The isolates from this site were determined to belong to the NA1 lineage, which is commonly distributed in infested areas of coastal California. Subsequent sampling and testing were unable to replicate the positive finding. 2021 SOD Blitz samples were collected from Del Norte County in June 2021. Once again, the samples from the 2019 NA1 site tested negative. However, the two PCR-positive detections mentioned above were made near the EU1 site along State Route 197. The site was revisited in October to collect additional samples to reconfirm these positive sites and produce isolates in culture for genotyping and further analysis.

Farther south, in Humboldt, Mendocino, and Sonoma Counties, USDA Forest Service Aerial Detection Survey results indicated that although local pockets of sudden oak death spread existed in 2021, tanoak mortality declined significantly from the previous two years, probably because the wave of mortality sparked by the very wet 2016-2017 winter had subsided. Some increased tanoak mortality was noted around Garberville in southern Humboldt County, and isolated groups of 1 to 5 dead tanoaks could be seen along the Highway 101 corridor between Garberville and Leggett (Mendocino County). However, sampling of many of these trees failed to implicate *P. ramorum*. Instead, a variety of other insect and pathogen pests were noted on dead and declining tanoaks (see "*Tubakia* and *Diplodia* of Oaks and Tanoaks").

New symptoms of SOD were noted on Jackson State Demonstration Forest in Mendocino County, especially along the upper stretches of the Big River along Highway 20, but none of the numerous collected samples tested positive for *P. ramorum*. Both southwestern and northwestern portions of Mendocino County were noted as locations where SOD continued to intensify.

Stream monitoring efforts for *P. ramorum* were coordinated by the Rizzo lab, Department of Plant Pathology, UC Davis and included 37 sites in Humboldt and Del Norte Counties. The pathogen was not

Tanoak mortality in Jackson State Demonstration Forest (Mendocino County). Photo by: M. Jones, UCCE

detected from any streams north or east of Redwood National Park. Notable positives included Mill Creek and Widow White Creek in McKinleyville (Humboldt County), sites that have been sporadically positive over the years despite the virtual absence of tanoak (*Notholithocarpus densiflorus*) or bay laurel (*Umbellularia californica*) in their respective watersheds (the streams are predominantly urbanized, coastal coniferous forest dominated by Sitka spruce (*Picea sitchensis*), riparian hardwoods, and ornamental plants). Farther south, positives came only from Yager Creek in central Humboldt County and Stanley Creek in southwest Humboldt County, both of which were previously positive.

Tribal land in Humboldt and Siskiyou Counties tested negative in SOD Blitz surveys.

Tanoak trees killed by *Phytophthora ramorum* at Point Reyes National Seashore (Marin County). Photo by: C. Lee, CAL FIRE

Bay Area and Central Coast

SOD Blitz 2021 surveys determined that new *P. ramorum* infections statewide were generally at lower levels than previous years, likely due to dry winter and spring conditions. Notable Bay Area sites where numerous new *P. ramorum* infections were found, however, included southern and western Marin County, the Oakland Hills (Alameda and Contra Costa Counties), and the Santa Cruz and Santa Lucia Mountains (Santa Clara, Santa Cruz, San Mateo, and Monterey Counties). Stream monitoring efforts in 2021 focused on five streams around the Monterey/San Luis Obispo County border, with two of the streams (Santa Rita and San Simeon Creeks in San Luis Obispo County) receiving special attention with intensive surveys along the lengths of the channels because they were previously positive. However, none of the four streams or 200 ground-based samples from San Luis Obispo County creeks tested positive. Salmon Creek Canyon (Monterey County, just across the county line), however, was severely infested with multiple strong PCR-positive samples.

Big Sur, Santa Lucia Mountains, and Carmel Valley all had significant infestations, while the well-sampled Toro Park was negative (all sites in Monterey County). Significant oak mortality was reported in areas but with unconfirmed SOD and likely associated with drought and native pathogens.

Multiple significant outbreaks were identified in the Santa Cruz Mountains in both San Mateo and Santa Cruz Counties, including at Filoli, Portola Redwoods, Huddart Park, El Corte De Madera Creek, Russian Ridge Open Space Preserve, Portola Redwoods State Park and Campground, Castle Rock State Park, and Sanborn County Park. Multiple outbreaks were identified in south and west Marin County. In the Oakland Hills, there were multiple outbreaks in the area between Mount Wanda to the northeast and Anthony Chabot Regional Park to the southwest. In Sonoma County, multiple outbreaks occurred throughout the county, but woodlands around Sonoma were negative.

In San Francisco County, both the Presidio and Golden Gate Park (including the nursery) were negative. Southern and southeastern Napa County were well-sampled and negative. Mount Diablo, eastern, and southern Alameda County tested negative, and suburban parks in the North Peninsula and in the South Bay (San Mateo and Santa Clara County) were negative.

Blue Gum Anthracnose and Branch Cankers (various fungi)
See “San Francisco Bay Area” under Abiotic Conditions, below.

Manzanita Tip and Branch Die-back (various fungi)
See “San Francisco Bay Area” under Abiotic Conditions, below.

Native Diseases

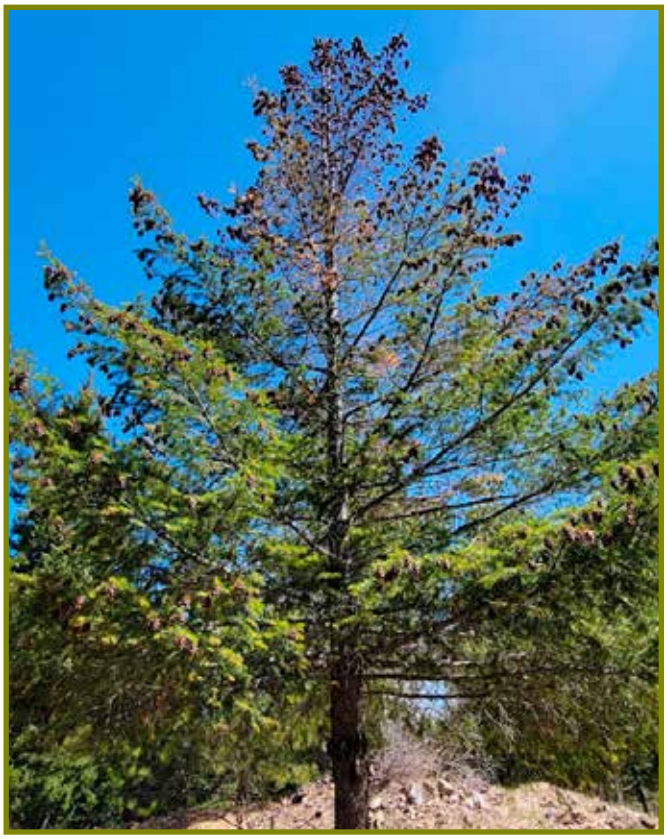
Root Diseases

Black Stain Root Disease (*Leptographium wageneri*)
A sampling effort led by scientists from Oregon State University collected woody tissue infected by *Leptographium wageneri* at two locations in Humboldt County near Buck Mountain west of Dinsmore and in Mendocino County in Jackson Demonstration State Forest. At each location, tissue was collected from five trees with thinning and reddening crowns, abnormally dense cone

crops, pitch issuing from the tree bases outside the bark, and black-streaked vascular tissue at the tree bases inside the bark. Work will be done on the genetics of this disease organism.

In an extension of the same sampling effort, ponderosa (*Pinus ponderosa*) and Jeffrey pine (*P. jeffreyi*) wood samples taken from more than 20 trees with black stain in six locations in northeast California were being studied at USDA Forest Service Research and Oregon State University labs in Corvallis, Oregon, to identify *L. wageneri* DNA and learn more about the genetic variability of the pathogen. Collections came from five ponderosa pines in Plumas County just southwest of Lake Almanor near Prattville; from three ponderosa pines in Lassen County in Blacks Mountain Experimental Forest; from three ponderosa pines in Modoc County northeast of Adin near Roney Flats; from three Jeffrey pines in Lassen County in a Heart Rock Black Stain Study plot; and six ponderosa pines in Modoc County, north of Crowder Flat.

Observations were made of declining single-leaf pinyon (*P. monophylla*) and bristlecone pine (*P. longaeva*). The declining trees had reddened crowns. In about 100 acres of bristlecones, 10 to 12 declining trees were observed on the White Mountains near the Methuselah Grove. Black stain root disease fungus (*Leptographium wageneri*) had been recovered from roots of one declining tree in 2006 in the same area. The research team from Oregon State University gathered wood samples from several declining bristlecones and recovered the black stain root disease fungus from many of them. DNA analysis of the fungi will determine which of the three varieties of the fungus infected these bristlecone pines. In a secondary survey a Forest Service Forest Health Protection entomologist was unable to find any evidence of mountain pine beetle (*Dendroctonus ponderosae*) attacking either the bristlecone or declining limber pines (*P. flexilis*).



Douglas-fir with symptoms of black stain root disease, Humboldt County. Photo by: C. Lee, CAL FIRE

Collecting black stain root disease samples from a ponderosa pine, Modoc NF, Modoc County. Photo by: W. Woodruff, USFS

Similar situations existed in stands of pinyon pine located less than a mile away and about 1,000 feet lower in elevation in the White Mountains, Inyo County. In about 100 acres of forest, there were around 20 to 30 declining pinyons. The level of decline and mortality did not match what had been seen in previous years but was significantly higher than had been observed in the past 2 to 3 years. Black staining was found in all sampled trees, and the black stain root disease fungus recovered from most of them.

While evidence of red turpentine beetle (*Dendroctonus valens*) attacks on these pinyon pines was occasionally detected, no evidence of any attacks by the pinyon ips (*Ips confusus*) were observed. It is speculated that in drought years trees originally infected with the black stain root disease fungus go into decline, and populations of pinyon ips build up. While no evidence of buildup of pinyon ips populations was observed, the situation will be monitored in 2022. Numerous areas of pinyon mortality also showed attack by pinyon scale (*Matsucoccus monophyllae*), but this was thought to be a minor pest compared to black stain root disease.

Heterobasidion Root Disease (*Heterobasidion occidentale* and *H. irregulare*)

Live grand firs (*Abies grandis*) of varying sizes were assayed for the presence of *Heterobasidion occidentale* in coastal areas in Sonoma, Mendocino, Humboldt, and Del Norte Counties in 2021. Detection ranged from 8% (at a site in north coastal Mendocino County) to 75% (at a site in Fortuna, Humboldt County). Several sites had positive detection levels of around 1/3 of the trees surveyed. Considering the limited sampling per site, this probably underestimates pathogen prevalence in these live grand firs. The trees, some of which were mixed with other species and some of which were in pure or nearly-pure grand fir stands, also suffered from infestations of balsam woolly adelgid (*Adelges piceae*), fir engraver beetle (*Scolytus ventralis*), *Armillaria* spp., and

other pests, indicating the need for complex consideration of their pest management.

Heterobasidion root disease was found in every forest throughout southern California on nearly every site visited in 2021 (Monterey, Los Angeles, San Bernardino, and San Diego Counties). *H. irregulare* on pines was not as prevalent as *H. occidentale* on fir. However, in nearly all sites there were abundant white fir (*Abies concolor*) seedlings near the dead and dying mature trees, indicating good regeneration.

Armillaria Root Disease (*Armillaria mellea* and *A. gallica*)

A species of *Armillaria* was collected from mycelial fans on two recently-killed grand fir (*Abies grandis*) trees at Lake Earl Wildlife Refuge in Del Norte County; this *Armillaria* species, identified by PCR and sequencing of the tef1 locus as *Armillaria mellea*, appeared to be killing or contributing to the mortality of scattered mature firs (1 to 2 trees per hectare) throughout this area.

Fruiting bodies of *Armillaria gallica*, identified via PCR and sequencing, were collected in late October at three Humboldt County locations: the crossing of Redwood Creek on Bair Road, where they were fruiting at the bases of several live bay laurels (*Umbellularia californica*); Azalea State Reserve in McKinleyville, where they were fruiting at the base of a live grand fir (*Abies grandis*); and College Cove north of Trinidad, where they were fruiting on a dead alder (*Alnus* sp.). At all three locations, other pathogenic fungi have been noted in the past on the same hosts, including *Armillaria nabsnona*, *Ganoderma brownii*, and *Heterobasidion occidentale*.

Armillaria spp. were commonly found in areas of tree mortality and decline in forests and in fire scars throughout southern California. Evidence in all cases of *Armillaria* infecting oak species (*Quercus* spp.) was the appearance of rhizomorphs on fallen trees. Observations were made on coast live oak (*Quercus agrifolia)* and California black oak (*Q. kelloggii)* over much of the front range of the San Bernardino NF, in discontinuous pockets totaling approximately 15,000 acres, on the southern edge of San Bernardino County. The number of observations of *Armillaria* spp. may be due to the increase in fire-injured or -killed trees that fall and expose the rhizomorphs on the roots.

Rhizomorphs were also seen on a coast live oak in the Los Padres NF in an area heavily impacted by sudden oak death (*Phytophthora ramorum*) in Monterey County.

Heterobasidion root disease pocket. Photo by: C. Lee, CAL FIRE

Locations of Heterobasidion root disease collections in southern California. Map by: C. Barnes, USFS

Armillaria gallica fruiting at the base of a living bay laurel in Humboldt County. Photo by: C. Lee, CAL FIRE

Armillaria rhizomorphs on coast live oak roots. Photo by: C. Barnes, USFS

Armillaria rhizomorphs on California black oak roots. Photo by: C. Barnes, USFS

Armillaria fruiting bodies were observed on Coulter pine (*Pinus coulteri*) and ponderosa pine (*P. ponderosa*) in two locations on the Cleveland NF in Riverside County. In both areas, the fruiting bodies were associated with cut stumps, suggesting the trees had died or were declining from the *Armillaria*. In one case in Riverside County, Coulter pine seedlings were planted within one foot of the fruiting bodies of an infected Coulter pine stump during reforestation efforts. This occurred in an area of approximately 50 acres.

Phytophthora Root Disease (*Phytophthora cinnamomi*)
Phytophthora cinnamomi was baited from soil beneath a severely declining stand of conifers and hardwoods along a slow-moving small watercourse in Hiouchi (Del Norte County). The site featured 7 to 10 mature dead and declining Douglas-firs (*Pseudotsuga menziesii*) as well as several nearly-dead California bay laurels (*Umbellularia californica*) and bigleaf maple (*Acer macrophyllum*) trees. Similar declining stands, some also including madrone (*Arbutus menziesii*) and tanoak (*Notholithocarpus densiflorus*), were seen in the surrounding area. *P. cinnamomi* was also baited from soil on both sides of State Route 197 under declining vegetation just west of Hiouchi, both in February and October. Both sites feature small drainages slowly meandering over heavy clay soils, potentially derived from serpentine parent materials upslope. Both sites also featured many dead Port-Orford-cedars, and one of them is a known Port-Orford-cedar root disease (*Phytophthora lateralis*) site.

Xylella bacterial infection on sweetgum.
Photo by: C. Barnes, USFS

Foliar Diseases

Calonectria californiensis

The newly named *Calonectria californiensis* was observed causing severe leaf spotting and sprout die-back on understory tanoaks (*Notholithocarpus densiflorus*) for several miles along Howland Hill Road in Jedediah Smith State Park (Del Norte County), on either side of the crossing of Mill Creek.

Xylem-Limited Bacteria (*Xylella fastidiosa*)
Xylella fastidiosa ssp. *multiplex* is a native bacterium that causes wilt disease in North America. Sweetgum (*Liquidambar styraciflua*), a common urban tree, can be severely impacted. The *Xylella* bacteria is vectored by the glassy-winged sharpshooter *Homalodisca vitripennis*. There were five PCR-verified *Xylella* infections of sweetgum in Redlands in San Bernardino County and two PCR-verified samples in Los Angeles County at the Huntington Gardens.

Maple Leaf Scorch (MLS) (Suspected *Xylella fastidiosa*)
Maple leaf scorch caused premature mortality of bigleaf maple (*Acer macrophyllum*) leaves, beginning at the leaf margins. The symptoms began in early summer and progressed into the fall. Xylem-feeding insects are suspected

Heavy maple leaf scorch on bigleaf maple along Highway 70 near Storrie, CA.
Photo by: W. Woodruff, USFS

Close up of maple leaf scorch symptoms on bigleaf maple.
Photo by: W. Woodruff, USFS

but not confirmed. The same is true for the bacteria *Xylella fastidiosa*. Climate change and lack of soil moisture may also be causing the symptoms. In 2021, light maple leaf scorch was observed along CA Highway 32 near Deer Creek. Heavy MLS was observed along Highway 70 near Feather River in Plumas County south of Storrie.

Tanoak mortality associated with *Diplodia mutila* and *Tubakia californica* near Leggett, Mendocino County.
Photo by: C. Lee, CAL FIRE

Branch Die-backs

California Bay Laurel Die-back (various fungi)

Tip and branch die-back plus cankering were seen in Sonoma and Marin Counties on California bay laurel (*Umbellularia californica*). The following fungi were identified: *Botryosphaeria dothidea* and *Neofusicoccum non-quaesitum* (previously reported in California); and *Neofusicoccum australe* and *N. luteum*, both of which are a first report for California bay laurel in California. These are all "Botryosphaeria fungi," latent pathogens known to infect their hosts as endophytes before switching to a pathogenic lifestyle when water stress increases in the plant host.

***Tubakia* and *Diplodia* of Oaks and Tanoaks** (*Tubakia californica and Diplodia* spp.)

Several pathogens caused diseases with symptoms easily confused with those of sudden oak death (*Phytophthora ramorum*) in the North Coast counties in 2021. For the most part, these pathogens take advantage of water stress conditions to aggressively colonize large amounts of tissue, sometimes killing twigs, branches, and whole trees. Many of them may have first spread and infected trees during the very wet 2016-2017 winter. Starting in early summer, UC Cooperative Extension and CAL FIRE sampled in several north coastal counties to associate observed symptoms with responsible pathogens. By November, 65 samples had been collected, and apparently pathogenic organisms isolated from Del Norte, Siskiyou, Humboldt, and Mendocino Counties. About half of them (30 samples) had been sequenced and identified by the CDFA Plant Pest Diagnostic Lab. Of these 30 samples, 17 were affected by *Tubakia californica*, four by *Diplodia corticola*, one by *Diplodia mutila*, three by *Biscogniauxia mediterranea*, one by another *Biscogniauxia* species, and five by *Diaporthe* species. Other potential pathogens were occasionally isolated, such as *Cladosporium* sp., *Paratubakia* sp., and *Apiognomonia errabunda* (on leaves). On some batches of samples, secondary pathogens or saprotrophs were mostly isolated, suggesting that more primary pathogens may have initially been responsible but that isolations had not been conducted early enough to detect them.

Additional isolations of *T. californica* and *D. corticola* were also made in other locations, particularly from coast live oaks (*Quercus agrifolia*) in Marin and Santa Cruz Counties. In Santa Cruz County, *D. corticola* was killing coast live oak seedlings; incubating the pulled-up, dead seedlings in moist conditions revealed abundant hyphae and fruiting bodies throughout the burls and root systems. In general, *D. corticola* was associated with symptoms on any part of an affected trees, including main stems, and appeared capable of quickly killing individual trees, while the other pathogens were more typically associated with twig cankers and individual branch tip death. In the case of *T. californica*, the pathogen appears capable of persisting and spreading in the tree canopy over years, potentially leading to further tree health complications. These are all known to be latent pathogens with an endophytic life phase. Insect pests were also noted on several of the collected samples, including sucking insects and the California oakworm (*Phryganidia californica*).

Large stands of tanoak (*Notholithocarpus densiflorus*) in Butte and Plumas Counties were examined for potential sudden oak death (*Phytophthora ramorum*) but were found to be infected with *T. californica* instead. Many true oaks (*Quercus* spp.) in the area were also infected. Symptoms included leaf and stem die-back and foliage remaining attached to the trees even after death.

Sydowia polyspora

Three to five grand firs (*Abies grandis*) on the ocean-facing slope at Sea Ranch (Sonoma County) had tip die-back caused by *Sydowia polyspora*. The fungus, previously noted causing shore pine (*Pinus contorta*) branch die-back in Humboldt County, was also associated with manzanita (*Arctostaphylos* spp.) tip die-back at Mt. Diablo (Contra Costa County).

Branch, Stem, and Bole Cankers

Botryosphaeria Canker (*Botryosphaeria dothidea*)
A half acre area of California bay laurels (*Umbellularia californica*) was affected by Botryospheria canker on Upper Lopez Lake Canyon Rd at Lopez Lake in San Luis Obispo County. All age classes of the bay laurels were impacted. Symptoms on these trees were long cankers that started at the base of the tree and extended in vertical strips up the trunk. Often these cankers were ten feet in length. The leaves were dead and remained on the tree. The area had burned two years before, and the affected trees were re-sprouting. This was the only known area where these symptoms were found. This location will be monitored in the future to see if the disease symptoms continue or cause any long-lasting damage.

California bay laurel affected by Botryosphaeria canker.
Photo by: K. Corella, CAL FIRE

Botryosphaeria Canker (*Diplodia corticola*)
A half acre of tanoaks (*Notholithocarpus densiflorus*) was affected by Botryospheria canker along Santa Rita Creek on the Land Conservancy of San Luis Obispo County property. These trees exhibited large bleeding basal cankers that caused the trees to break and fall. Symptoms also included crown and branch die-back. Single branch die-back symptoms were also seen on tanoaks along the East Cuesta Grade Rd. The dozen or so tanoaks present all had symptoms of *Diplodia corticola*.

Large bleeding Diplodia canker on tanoak.
Photo by: K. Corella, CAL FIRE

Web Blight (*Rhizoctonia* sp.)
Web blight caused by an aerially-dispersed *Rhizoctonia* sp. was observed associated with die-back of lower branches of western hemlock (*Tsuga heterophylla*) in Jedediah Smith State Park in Del Norte County. At this location, many mature western hemlocks growing in the drainages of the main stem of the Smith River and its tributary Mill Creek had severely thinning crowns with scattered trees gradually dying. Web blight, which has previously been observed throughout coastal Oregon causing similar die-back in both Douglas-fir (*Pseudotsuga menziesii*) and western hemlock, is marked by the production of profuse grayish hyphal strands (resembling webs) that grow among needles and branches; affected needles blacken and drop. Other pathogens that are also affecting mature western hemlock trees in the park include western hemlock dwarf mistletoe (*Arceuthobium tsugense* ssp. *tsugense*) and the root pathogens *Heterobasidion occidentale*, *Armillaria* sp., and *Pseudoinonotus dryadeus*. Although new die-back and mortality were sufficiently severe to be visible from the air, dead trees were fairly scattered and uniformly distributed from very old stumps and snags to recently killed trees, perhaps indicating that these pathogens are part of a normal successional process in this old-growth forest with little to no fire during the twentieth century.

Web blight caused by *Rhizoctonia* sp. on western hemlock in Jedediah Smith State Park (Del Norte County. From left to right: blackening needles, close up of mycelium on needles, right-angled hyphae characteristic of *Rhizoctonia* sp. Photos by: C. Lee, CAL FIRE

Foamy Bark Canker (Coast Live Oak decline) (*Geosmithia* sp.)
In San Luis Obispo County, a half dozen coast live oak trees (*Quercus agrifolia*) were affected by foamy bark canker near Avila Beach. The trees had over 100 successful attacks from western oak bark beetle

Close up of *Fomitiporia fissurata*. Green Valley, Los Angeles County.
Photo by: C. Barnes, USFS

Ganoderma brownii fruiting body in Bouquet Canyon, Los Angeles County.
Photo by: C. Barnes, USFS

(*Pseudopityopthorus pubipennis*). Although crown symptoms were minimal, masses of foam existed at the entry and exit holes. The crowns of these trees were full and green, and insecticide treatments were applied to the trees.

A landowner requested assistance identifying foamy spots on canyon live oaks (*Quercus chrysolepis*) in an active fuel break in August. Additional foamy spots were observed on a CAL FIRE fuel break during maintenance in October at elevations about 2,500 feet, east and west on Highway 49 in southern Mariposa County. Attacks were on dozens of live oaks at each active fuel break. Specialists attributed the foamy spots in submitted photos and descriptions to the western oak bark beetle (*Pseudopityophthorus pubipennis*). This beetle can also vector foamy bark canker. Increased attacks by western oak bark beetles have been reported from El Dorado County through Mariposa County in recent years with resulting foamy bark. Cut logs were not solarized, as no symptoms were apparent before shaded fuel break maintenance was conducted.

Heart and Sap Rots

Fomitiporia fissurata

Fomitiporia fissurata caused white rot on living *Quercus* spp. in southwest California. This is a new scientific name for the fungus. *F. fissurata* was previously identified as the cosmopolitan *F. robusta* but was re-named in 2016 based on morphological characteristics and DNA sequence analysis. To date, *F. fissurata* has been found only in southern California, Arizona, and New Mexico. The original specimen for *F. fissurata* was from the Cleveland NF near Mt. Laguna. DNA analysis of the sequence available in GenBank suggests this white rot has been in this region for a long time.

Ganoderma spp.

Both laccate (appearing lacquered) and non-laccate *Ganoderma* species were found causing heart rot in southern California in 2021 (Los Angeles, San Bernardino, and San Diego Counties). The only non-laccate *Ganoderma* was *G. brownii*, found on several coast live oaks (*Quercus agrifolia*) on the Angeles NF in a 150-acre area. The identity of the sample was confirmed by DNA sequence. *G. brownii* was also found causing heart rot on bay laurel (*Umbellularia californica*) in the Soquel sudden oak death demonstration plot in the Los Padres NF, confirmed with DNA sequencing. The area was used for a project in 2013-2014 using the potential biocontrol *Chondrostereum purpureum* to reduce bay laurel re-sprouting in the demonstration plot. At the time, the authors of the project noted *Ganoderma* root and heart rot in the area. As of 2021, most of the stumps had more *Ganoderma* than *C. purpureum*.

G. sessile was found on a total of 15 urban sweetgum (*Liquidambar styraciflua*) trees at two locations, at the Huntington Gardens (Los

Ganoderma brownii fruiting body on California bay Laurel.
Photo by: C. Barnes, USFS

Ganoderma sessile fruiting body in the Huntington Gardens, Los Angeles County. Photo by: C. Barnes, USFS

Ganoderma sessile fruiting body on sweetgum in Redlands, San Bernardino County. Photo by: C. Barnes, USFS

Angeles County) and in Redlands (San Bernardino County). Species were verified by DNA sequence from a conk in Redlands. *Ganoderma sessile* was found growing in a brown rot pocket on a dead white fir (*Abies concolor*) in El Dorado County. The species has not been confirmed, but most laccate *Ganoderma* on conifers in California are known to be *G. oregonense*.

Rust Diseases

Western Gall Rust (*Peridermium* (*Endocronartium*) *harknessii*)

Western gall rust was documented at several locations. The first was an isolated infection on Monterey pine (*Pinus radiata*) in Lobos Park, Monterey County. The second was on lodgepole pine (*P. contorta*) on the Eldorado NF in El Dorado County.

Western gall rust was also found causing extensive die-back in an isolated stand of shore pine (*P. contorta*) on Santa Rosa Island in the Channel Islands National Park, Santa Barbara County. The stand was very mature and lacked any significant regeneration.

Mistletoes

***Phoradendron* and *Arceuthobium* spp.**

An increasing number of incense-cedar (*Calocedrus decurrens*) and California black oaks (*Quercus kelloggii*) were infected with true (leafy) mistletoe (*Phoradendron libocedri* and *P. villosum*) in Riverside County. Previously, mistletoes were commonly seen on live (*Q. agrifolia*) and scrub oak (*Q. dumosa*), but there was an increase in mistletoes on these two species in the Pine Cove and Mountain Center areas. The trees may be susceptible to other pests and stressors due to the weakening caused by the mistletoe infections.

Leafy and dwarf mistletoe rivalled *Heterobasidion* root disease as the most-observed disease problem in southern California in 2021. The leafy mistletoe *Phoradendron* spp. were observed on numerous hosts, including *P. macrophyllum* on sycamore (*Platanus racemosa*), and cottonwood (*Populus fremontii*), *P.*

Ganoderma oregonense with associated brown cubical rot, El Dorado County. Photo by: C. Barnes, USFS

Western gall rust on lodgepole pine, Eldorado NF, El Dorado County. Photo by: C. Barnes, USFS

Western gall rust on lodgepole pine, Eldorado NF, El Dorado County. Photo by: C. Barnes, USFS

Western gall rust on bishop pine, Santa Rosa Island, Channel Islands National Park, Santa Barbara County. Photo by: K. Corella, CAL FIRE

The leafy mistletoe *Phoradendron macrophyllum* on sycamore, Los Angeles County.
Photo by: C. Barnes, USFS

Leafy mistletoe infestation on cottonwood, Los Angeles County. Photo by: C. Barnes, USFS

Leafy mistletoe *Phoradendron libocedri* on incense-cedar, San Bernardino County. Photo by: C. Barnes, USFS

libocedri on incense-cedar (*Calocedrus decurrens*), and *P. villosum* on black oak (*Quercus kelloggii*) and canyon live oak (*Q. chrysolepis*). The dwarf mistletoe *Arceuthobium campylopodum* was found on Coulter pine (*Pinus coulteri*) and *A. abietinum* f. sp. *concoloris* on white fir (*Abies concolor*). These observations and many others were made in the Angeles, San Bernardino, and Cleveland NFs in Los Angeles, San Bernardino, Riverside, and San Diego Counties.

The introduced European leafy mistletoe (*Viscum album*) continued to spread around the Sebastopol area in Sonoma County. Surveys found the plant on trees farther out from the original point of introduction identified decades ago. The mistletoe continues to spread at a slow but steady rate.

Dwarf mistletoe on white fir, San Bernardino County.
Photos by: C. Barnes, USFS

Western dwarf mistletoe on Coulter pine, Kern County.
Photo by: C. Barnes, USFS

A large heat dome existed over California for an extensive period during the summer of 2021. When the heat combined with the ongoing drought conditions in the state, numerous species of trees and shrubs suffered, including the following:

San Luis Obispo County

Valley (*Quercus lobata*) and blue oaks (*Q. douglasii*) were dying back over 10,000 acres in Bradley just west of Highway 101 in San Luis Obispo County. The trees had sparse canopies and tended to fall at the base after 5 to 7 years. There were no insects or pathogens found to be causing the death and die-back. Lowering of the water table and extreme temperatures during the year were suspected to be the cause of the accelerated mortality.

San Francisco Bay Area

Die-off and decline of numerous hardwood and conifer species were reported throughout much of the San Francisco Bay Area starting in October 2020. This collapse or degradation of tree health was associated with low precipitation and high evaporative demand plus reduced fog in the region that has been in intense drought. Each of the affected tree species displayed a different pattern of decline due to the tree species' physiological response to drought and heat as well as its associated biological agents - fungi or insects - triggered by stress. Descriptions of what is known about the causal agents for acacia, eucalyptus, Monterey pine, knobcone pine, coast redwood, bay laurel, and manzanita species are provided in separate sections below.

The U.S. Forest Service, Pacific Southwest Region, Aerial Detection Survey recorded 900 acres of acacia mortality (primarily *Acacia melanoxylon*) and 1,300 acres of eucalyptus mortality (*Eucalyptus globulus* and other species), with concentrated severe mortality around the San Pablo Reservoir (Contra Costa County) and southward. Conifer mortality was detected across over 1,000 acres; affected species included Monterey pine (*Pinus radiata*), gray pine (*P. sabiniana*), knobcone pine (*P. attenuata*) and redwood (*Sequoia sempervirens*).

Pockets or stand-level mortality 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); Mount Diablo State Park and throughout Richmond (Contra Costa County); and many other areas throughout the Bay Area. Severe redwood (*Sequoia sempervirens*) discoloration was detected west of Palo Alto on 2,700 acres (San Mateo County). Eucalyptus discoloration was observed across the area and along the entire Central Coast of California.

In 2021, 1,500 acres of dead and dying trees were reported by East Bay Regional Parks District on their lands (Alameda and Contra Costa Counties). The District labelled the problem "sudden tree die-off" and as of fall 2021 removed over 765 trees considered hazardous in Reinhardt Redwood and Miller/Knox Regional Parks. East Bay Municipal Utility District (EBMUD) reported to its customers that Monterey pine trees on watershed lands in the East Bay (Alameda County) and Sierra foothills (Amador and Calaveras Counties) were dying, leading EBMUD to escalate efforts to remove dry vegetation that can contribute to fuel loads during wildfire.

Monterey pine was one of the species most commonly observed dying in the Bay Area Counties, with many dead trees removed to reduce hazards to urban areas. The trees typically died due to weather-related stress combined with red turpentine beetle (*Dendroctonus valens*). The canker-causing fungus *Diplodia scrobiculata*, although not specifically identified on dying pines, very commonly killed individual branches and parts of drought-stressed Monterey pine crowns in northern California; additionally, Monterey pines located in humid areas and near water bodies in the East Bay displayed symptoms of pitch canker (*Fusarium circinatum*).

Dead and declining blackwood acacia (*Acacia melanoxylon*) and silver wattle (*Acacia dealbata*) were observed in many locations throughout the Bay Area. Many of the weakened or dead trees showed prominent cankers, at the soil line or higher on the boles. Stands of acacias collapsed in fall 2020. Some trees re-sprouted in 2021, but most had died. The trees were hypothesized to be in decline due to a combination of environmental stress and endophytic fungi that caused the cankers. Acacia is not native to the Bay Area and frequently establishes in vacant lots or unmanaged sites.

To determine the biotic agents contributing to the acacia die-back and mortality, UC Berkeley scientists examined declining trees at four locations (Leona Heights/Montclair - Oakland, Dimond Canyon - Oakland, Carquinez Strait – Crockett, and Burlingame - San Mateo County). Two fungi were identified at all sites, *Diaporthe foeniculina*

Dead and dying acacias in Leona Heights, Oakland, Alameda County, in September 2021. Photo by: S. Frankel, USFS

Declining eucalyptus stands on East Bay Regional Parks lands, Contra Costa County.
Photo by: East Bay Regional Parks District

Acacia (trunk on right) showing canker development on a declining tree near Montclair, Oakland, Alameda County.
Photo by: S. Frankel, USFS

and *Dothiorella viticola*. Additionally, *Dothiorella moneti* was found in Leona Heights/Montclair where it was associated with stand-level mortality. *Umbelopsis ramanniana* was found acting as a pathogen on multiple trees at one location. Stem or branch cankers were common in this area; in cross-section, the cankers show a pie-shaped wood discoloration, which is consistent with disease caused by these fungi. The fungi are typically endophytes, living inside trees without any obvious effect on tree health, then become pathogens - some relatively aggressive - in conjunction with the onset of predisposing stress factors (drought, heat stress). The fungi then survive as saprobes on the wood of the dead trees.

Internal discoloration typical on declining *Acacia melanoxylon*. Photo by: S. Frankel, USFS

Throughout the Bay Area, eucalyptus trees (particularly blue gum, (*Eucalyptus globulus*) were observed with thin crowns, twig die-back, and brown spots and holes on leaves. Symptoms were generally limited to the foliage and twigs. To determine the biotic agents involved in this widespread eucalyptus die-back, UC Berkeley scientists examined six sites around the Bay Area: two sites in the Crystal Springs Reservoir watershed (San Mateo County) and one each in Tilden Regional Park (Contra Costa County); Albany Hill, Albany (Alameda County); Anthony Chabot Regional Park (Alameda County); and Carquinez Strait Shoreline Regional Park (Contra Costa County). Several minor insect and disease agents were found, but since no primary insect or pathogens were found consistently associated with the declining eucalyptus, the die-back is likely due to drought and heat stress. Also, the widespread and synchronous appearance of the canopy weakening, which appeared after periods of high temperatures and a lack of rain, fit with the theory that the problem is driven by abiotic, climatic factors.

Redwood die-back caused by *Neofusicoccum nonquaesitum* in Clayton (Contra Costa County).
Photo by: C. Lee, CAL FIRE

Coast redwoods (*Sequoia sempervirens*), particularly those planted on roadsides or in other urbanized situations, exhibited severe top and branch die-back in many locations throughout the greater Bay Area. Examination of individual trees showed that most of this die-back was caused by so-called “Botryosphaeria canker” fungi, which, like the fungi infecting Bay Area acacias, are stimulated to become aggressively pathogenic under conditions stressful to the host. In Clayton (Contra Costa County), numerous planted redwoods in hedges and along roadsides with dying tops, dying branches, and complete mortality in some cases were infected with *Neofusicoccum nonquaesitum*, while in Ukiah (Mendocino County), a group of 10 large redwoods planted along Highway 101 suffered top and branch die-back caused by *Neofusicoccum parvum* and *Diplodia mutila*. These and other “Botryosphaeria canker” fungi have previously been shown to be responsible for die-back of coast redwoods planted in southern California, and it was likely that they were responsible for a large part of the coast redwood die-back elsewhere in the Bay Area.

On Mt. Diablo, large portions (approx. 20 to 40 acres each) of knobcone pine (*Pinus attenuata*) stands on south-facing slopes, as well as individual gray pines (*P. sabiniana*) all over the mountain, were being killed by drought and heat in association with several native forest pests, including *Orthotomicus* (*Ips*) *spinifer*, western gall rust (*Peridermium harknessii*), and the dwarf mistletoe *Arceuthobium occidentale* on gray pine and *Ips paraconfusus* and *A. occidentale* on knobcone pine.

Also on Mt. Diablo and visible along roadsides from Mendocino County through the South Bay and in the Sierra foothills, was dramatic manzanita death, which began as die-back of individual branch tips and progressed to whole-shrub mortality. On Mt. Diablo, affected manzanita species included common manzanita (*Arctostaphylus manzanita*), Mt. Diablo manzanita (*A. auriculata*), and bigberry manzanita (*A. glauca*). Drought and heat appeared to be the major cause, although several fungi were isolated from the impacted plants (see San Francisco Bay Area section, page 28).

Dead manzanita on Mount Diablo (Contra Costa County). Photo by: C. Lee, CAL FIRE

Bay laurels (*Umbellularia californica*) from Marin County down through the South Bay exhibited a range of symptoms in 2021 including crown die-back, browning canopies, branch cankers, and leaf browning and spotting. Fungi isolated from symptomatic tissues included *Kabatiella* spp., *Botryosphaeria dothidea*, *Neofusicoccum australe*, *Neofusicoccum nonquaesitum*, and *Neofusicoccum luteum*.

Altogether, twelve of the biotic agents isolated from symptomatic Bay Area trees by the UC Berkeley Forest Pathology and Mycology Laboratory constituted first reports for California, including *Neofusicoccum australe* and *Neofusicoccum luteum* on bay laurel; *Neofusicoccum australe*, *Diaporthe australafricana*, and *Cytospora austromontana* on manzanita species; *Diaporthe foeniculina*, *Dothiorella viticola*, *Dothiorella moneti*, and *Umbelopsis ramanniana* on acacia; and *Pseudosydowia eucalypti*, *Neofusicoccum eucalyptorum*, and *Cytospora eucalypticola* on eucalyptus.

Salt and wind damage to coast redwoods at McKinleyville (Humboldt County, left) and Inglenook (Mendocino County, right). Photos by: M. Jones, UCCE

Wind and Salt Damage

Coast redwoods growing within a quarter-mile of northwest-facing shorelines on the North Coast sustained heavy damage that showed up as branch tip browning progressing to whole-branch defoliation throughout large areas of the crowns. It was speculated that this flagging and branch death were due to heavier-than-normal wind exposure during the winter since northwesterly winds were 3 to 5% more frequent during the 2020-2021 winter than during the previous five winters. Since these salt-bearing winds were coupled with less precipitation than normal, salt had less occasion to be washed off foliage (coast redwoods are known to be exceptionally salt-sensitive), and drought stress may have further contributed to tree desiccation. The two areas of the North Coast where this damage was most noticeable were the Humboldt Bay area in Humboldt County and Inglenook in Mendocino County. By the autumn, affected redwood trees began to re-foliate on many of the damaged branches.

Giant sequoias snapped mid-bole after toppling over due to Mono winds. Photos by: B. Bulaon, USFS

Winter Storms

A severe Mono Wind event occurred mid-January 2021 that caused severe damage and blowdown at several locations from the Eldorado to the Sequoia NF. El Dorado, Amador, Tuolumne, Mariposa, and Madera Counties all reported multiple locations where winds battered down entire stands, live and dead trees. Some locations were more damaged than others, and subsequent insect activity has occurred (see Cedar Bark Beetle section).

Winter storms uprooted 26 ancient giant sequoias (*Sequoiadendron giganteum*) within the lower and upper Mariposa Grove, Yosemite National Park (Mariposa County). Several other sequoias were toppled in Aspen Valley (Tuolumne County) on private property.

An estimated 200 trees suffered broken tops in a mature ponderosa pine plantation near Greys Mountain (Madera County). The broken tops led to an infestation of pine engraver beetles (*Ips* spp.). A revisit of this site will occur in 2022.

During a site visit to the 2020 Castle Fire in spring 2021, Forest Service Forest Health Protection documented giant sequoias that were injured by fire then knocked down by winter storms. In the permit housing tract in Belknap Grove (Tulare County), a house spared from fire was damaged by large sequoia limbs (>15 inches DBH) falling from above.

Along Highway 88 between Foster Meadows and Mormon Emigrant Trail turnoff (El Dorado and Amador Counties), blowdown occurred at several places and was also reported at other scattered locations on the Eldorado NF. Ground surveys of the Highway 88 blowdown found areas as large as 5 to 10 acres where mature red firs (*Abies magnifica*) and lodgepole pines (*Pinus contorta*) were cleanly uprooted from the ground. Live and dead trees were broken or snapped as high as 20 feet from the base. East-facing slopes experienced higher levels of damage than flatter or western slopes.

Damage from Heavy Snowfall

Because of several winter storms in December 2021, several counties experienced unusual treefall and stem and branch breakage from heavy snow. In Humboldt and Trinity Counties, lower-elevation sites along Highways 299 and 96, including some areas within the 2021 Monument Fire footprint, experienced very high levels of treefall and stem breakage that put hundreds of trees across roadways and led to electricity failures lasting for two weeks or more in some places. The impacts of the snow, particularly in lower-elevation sites where the snow was wetter, included uprooting and branch breakage in oak trees as well as bending and snapping of Douglas-fir and other conifers. In Placer, Nevada, Amador, and El Dorado Counties, the same kinds of impacts were reported, and crews from state transportation and emergency response agencies were ordered to clear dead trees on state highways. To free up response resources and facilitate clean-up and power restoration, the Governor issued an order proclaiming a State of Emergency that covered Alameda, Amador, Calaveras, El Dorado, Humboldt, Lake, Los Angeles, Marin, Monterey, Napa, Nevada, Orange, Placer, Sacramento, San Bernardino, San Mateo, Santa Cruz, Sierra, and Yuba Counties.

Giant sequoia branch failure caused damage to permit housing, Belknap Grove, Sequoia NF. Photo by: B. Bulaon, USFS

Snow damage near Redwood Creek, Humboldt County. Photo by: C. Lee, CAL FIRE

Porcupines (*Erethizon dorsatum*)

Porcupine damage was seen on mature Jeffrey pines (*Pinus jeffreyi*) around the Northstar Ski Resort Community, Truckee in Nevada County. Bark had been gnawed in large patches on at least a dozen trees, exposing the wood underneath. None of the trees had been girdled, and all were expected to live. Porcupines had been previously observed in the area feeding on tree bark and chewing on wooden signs.

First Release of Yellow Starthistle (*Centaurea solstitialis*) Biocontrol

A USFS Forest Health Protection Biological Control of Invasive Forest Pests (BCIFP) grant-supported project made progress in exploring methods to control yellow starthistle (YST), a prolific seeder that prevents the establishment of other species. The following two projects were designed to develop biocontrol methods and technologies that address the spread and impacts of noxious weeds in the state.

One study aims to design successful rearing methods and measure the establishment and impact of the rosette weevil (*Ceratapion basicorne*) in the field. 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 on April 8, 2021 at a site with dense populations of YST, including many standing skeletons from the previous year.

So far, the weevils that were released in April successfully infested YST plants at the release site, and their progeny completed development. The project continues to gather data on weevil populations in the field over time, as well as the attack rate by the rosette weevil, as measured by root diameter, plant height, and potential number of flower buds per plant. This is a good first step towards establishment; however, it will be important to determine if they survive until next spring and start another generation.

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Yellow starthistle (*Centaurea solstitialis*). Photo by: Doug Greenberg

Beth Brenneman releasing adult weevils at Magnolia Ranch site 1 on April 8, 2021, El Dorado County. Photo by: S. Oneto, UCCE

Arundo donax and Cape-ivy (*Delairea odorata*) Biocontrol

A USFS Forest Health Protection Biological Control of Invasive Forest Pests (BCIFP) grant-supported project made progress in exploring methods to control giant reed (*Arundo donax*) and Cape-ivy (*Delairea odorata*) in southern California. Giant reed is a tall perennial grass that typically forms dense stands on disturbed sites, sand dunes, riparian areas, and wetlands, altering hydrology and water availability for other species. Cape-ivy is a perennial vine that is especially problematic in riparian areas, forming dense mats of vegetation over trees and shrubs, killing plants underneath, and fish when the mats form above water.

The project wrapped up cooperative research in 2021 to compare the behavior of the imported *Arundo* wasp, *Tetramesa romana*, that has been released in Texas and the adventive form of *T. romana* that was previously documented to be present in southern California. Genetic analysis will more clearly discriminate subtle genetic differences potentially associated with differential establishment and impact traits. A joint manuscript is currently being prepared for a comparison of the adventive population of the Arundo wasp, *Tetramesa romana*, and its imported counterpart.

Cape-ivy infestation at Toro Canyon Park, Santa Barbara County. Photo by: T. Dudley, UCSB

A manuscript was also prepared and accepted for publication in the journal Insects documenting the density, range, impact, and genetic relatedness of the Arundo armored scale, *Rhizaspidiotus donacis*, comparing the ecology of the adventive form of the scale insect that the study discovered in southern California with the form being introduced by USDA-ARS (Braman et al., 2021).

Numerous field releases of the Cape-ivy gall-fly (*Parafreutreta regalis*) continued along with monitoring to assess establishment and expansion of fly populations at *D. odorata*-infested sites. The project has five sites where *P. regalis* is established and will serve as a nursery source for subsequent releases with a potential for six other sites to become established. A survey was completed at the second round of release sites from 2019-2020 that showed modest establishment and gall formation in 2021. Monitoring at trial release sites in San Luis Obispo and Santa Barbara Counties showed densities of fly populations were highest in early summer, although fly mortality was observed where drought conditions compromised healthy foliage that is required by the flies.

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Invasive Plants Program

In 2021 USFS State and Private Forestry's Forest Health Protection-Invasive Plants Program awarded the CDFA $100,000 to combat the spread of noxious weeds and non-native invasive plant species that threaten the health of managed and wild forest ecosystems in California. Targeted species will include CDFA A, A- or Q-rated and Section 4500 noxious weeds, including (but not limited to) spotted knapweed, diffuse knapweed, squarrose knapweed, leafy spurge, dalmatian toadflax, Scotch thistle, musk thistle, plumeless thistle, yellow starthistle, Scotch broom, and French broom, among many others. The project will administer funding to local and NGO entities for the early detection and control of noxious and invasive weeds, with a goal of treating 500 acres by partnering entities.

In 2021, scientific publications concerning California forest pests and wildland conditions included:

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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.

There were no committee field trips in 2021 due to statewide COVID-19-related restrictions. The CA Forest Pest Council annual meeting was held Nov. 17-18, 2021 and was virtual, also due to statewide COVID-19-related restrictions. No resolutions were passed during the annual meeting.

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