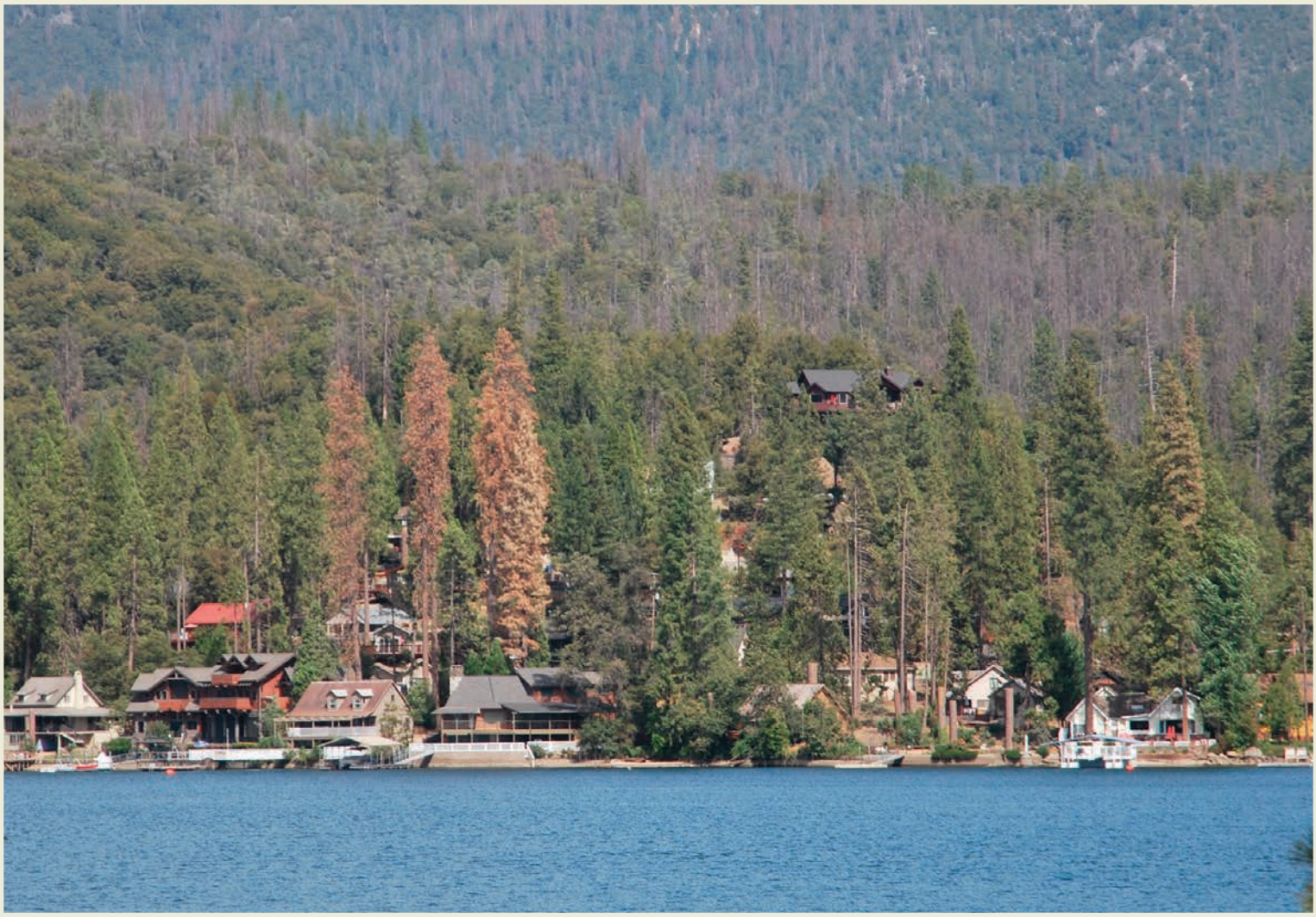
2018
California Forest Pest Conditions



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California Forest Pest Council

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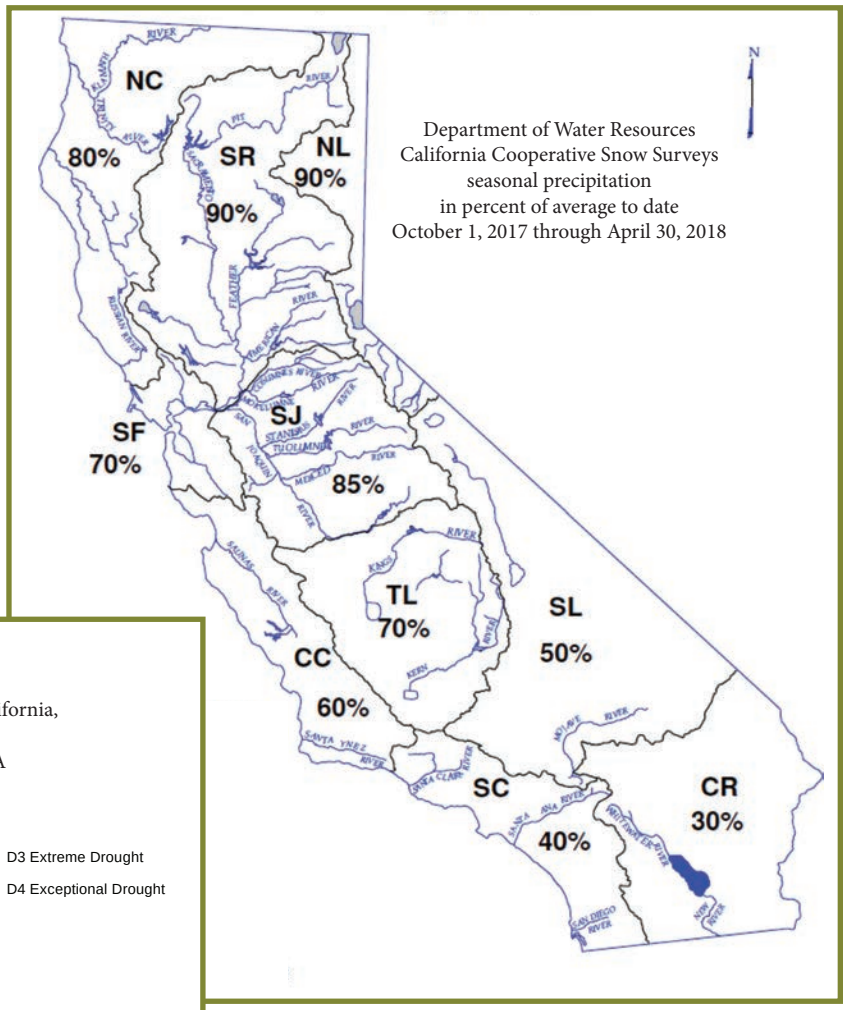
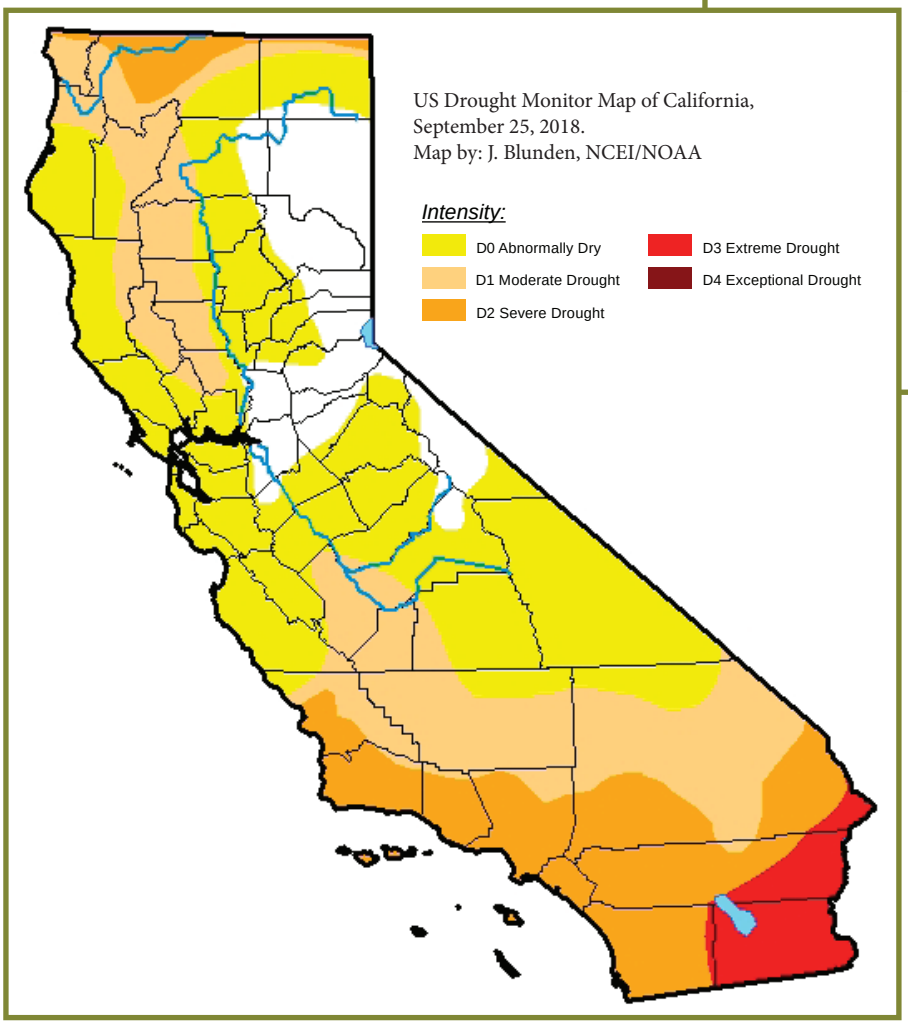
Statewide precipitation from October 2017 - April 2018 was 75% of average, compared to 170% for the same time period in 2016-2017. Northern California forested area rainfall totals were 80 - 90% of average and southern coastal areas were 40% of average (see map). The 2017-2018 water year (the water year is from October 1 – September 30) was the 14th driest on record (since January 1895) and the driest since 2014. Most precipitation occurred in November 2017 and January and April 2018.

It was also the state's third warmest year on record (since January 1895), with July being the warmest month ever recorded (4.9° F above the July average), and January the third warmest month on record.

Lingering impacts from the 5-year drought, overstocked forests, and higher than average temperatures were the most significant factors affecting California forest health in 2018, with ~18 million dead trees mapped across 2 million acres (US Forest Service Aerial Detection Program). This is the second year in a row that tree mortality levels have declined statewide, down from a high of 54 million dead trees in 2016.

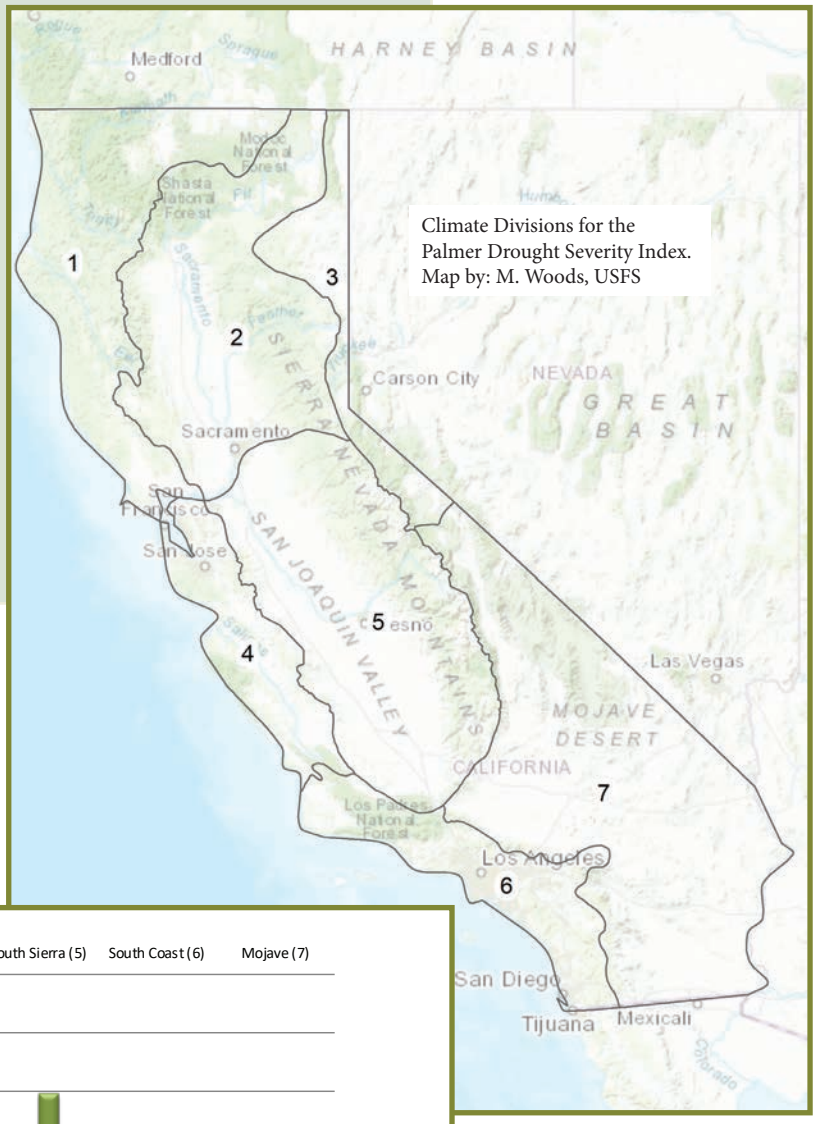
The Camp Fire (Paradise and surrounding area, Butte County) was the deadliest and most destructive fire in California history, taking 85 lives, destroying 18,804 structures, and burning 153,336 acres. Statewide, 7,571 fires consumed 1,671,203 acres (http://cdfdata.fire.ca.gov/incidents/incidents_stats?year=2018, accessed March 21, 2019), killing millions of trees and leaving millions more weakened.





Palmer Drought Index

The Palmer Drought Severity Index (PDSI) is an indicator of drought and moisture excess, with negative values denoting degree of drought. In 2018, the yearly average PDSI values ranged from -0.24 in the Great Basin (least dry zone) to -4.93 in the South Coast (driest zone) (see map). The South Coast was the only zone that did not observe some reprieve from drought in the 2016-2017 water year, compared to the rest of the state (denoted by positive numbers).



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

2018 Aerial Detection Survey
37 million acres surveyed
2 million acres with tree mortality
18 million dead trees

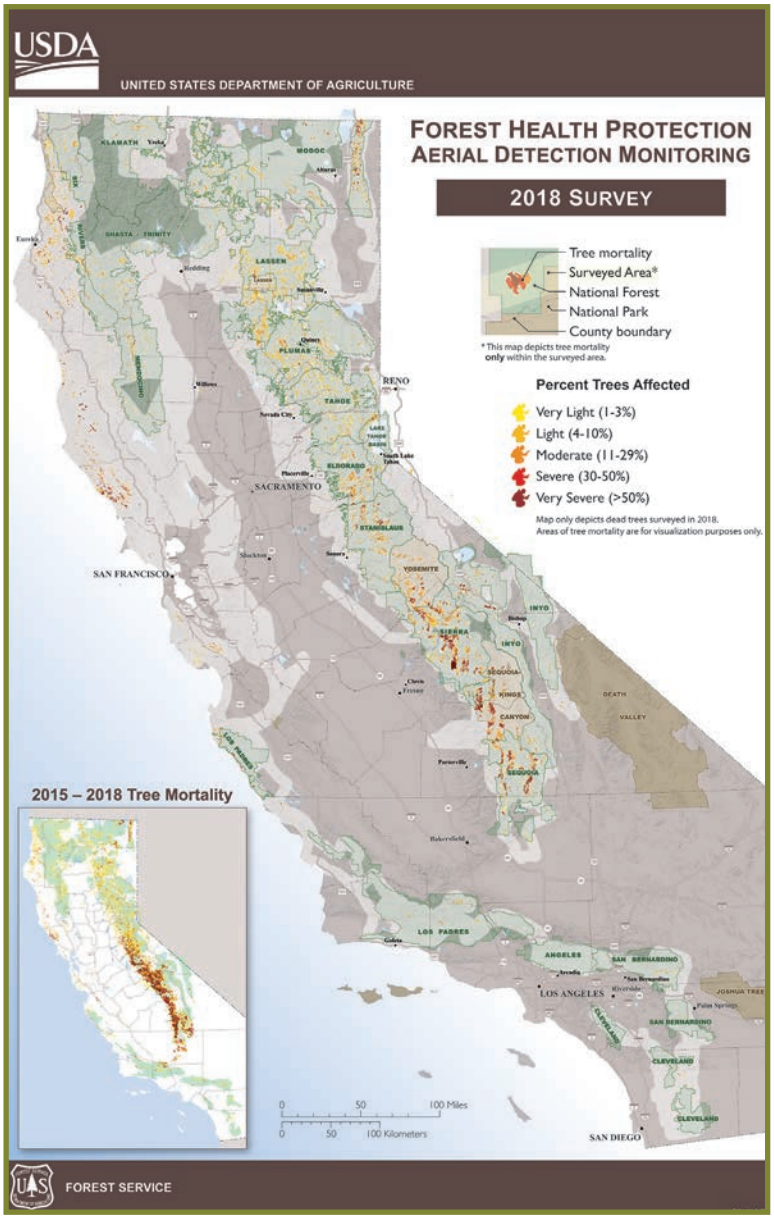
US Forest Service (USFS), Pacific Southwest Region, State and Private Forestry staff conduct annual aerial surveys throughout forested areas of California to detect recent tree mortality, tree damage, and defoliation. Surveys are flown in a small, fixed-wing aircraft on a 4-5 mi grid pattern with 2 observers 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 2018 flight season, approximately 37 million acres were surveyed. Elevated levels of tree mortality were recorded on ~2 million acres, totaling an estimated 18 million dead trees. Mortality had previously not been recorded during the drought on 801,000 of the acres identified (primarily fir- and tanoak-dominated forests). Most mortality was attributed to lingering effects of the recent exceptional drought (affecting California since 2012) and subsequent successful bark beetle attacks, which has resulted in a total of ~142 million dead trees since 2012.

Surveys were primarily flown from July - September. Some surveys were delayed due to wildfires and poor visibility. Some flight lines were greater than the standard 4-mi grid, and some areas were not flown, also mostly due to wildfires and poor visibility.

Bark Beetles and Wood Borers

- California red fir (*Abies magnifica*) and white fir (*Abies concolor*) mortality comprised over 75% of the total tree mortality observed in 2018. Approximately 14 million dead firs were recorded across 1.4 million acres, compared to ~23 million dead fir trees across 2 million acres in 2017.
- Goldspotted oak borer (*Agrilus auroguttatus*)-related oak mortality in San Diego County decreased to ~11,000 dead trees across 3,700 acres, down from ~16,000 dead trees across 5,700 acres in 2017.
- Western pine beetle (*Dendroctonus brevicomis*)-related pine mortality decreased to ~950,000 dead trees across 166,000 acres, a decrease from ~4 million dead trees across 330,000 acres in 2017.
- Jeffrey pine beetle (*Dendroctonus jeffreyi*)-related Jeffrey pine mortality decreased from ~1.4 million dead trees across 139,000 acres in 2017 to ~753,000 dead trees across 99,000 acres in 2018.



USFS Aerial Detection Survey, Tree Mortality, 2018.
Map by: M. Woods and A. Ellis, USFS

Fir mortality across Ishi Wilderness, Lassen NF. Photo by: J. Pope, USFS

White fir mortality, El Dorado NF. Photo by: J. Pope, USFS

Scattered oak mortality near Los Padres NF. Photo by: J. Moore, USFS

Aspen defoliation east of Inyo NF. Photo by: L. Mcafee, Quercus Consultants Inc.

Tanoak mortality west of Mendocino NF. Photo by: J. Moore, USFS

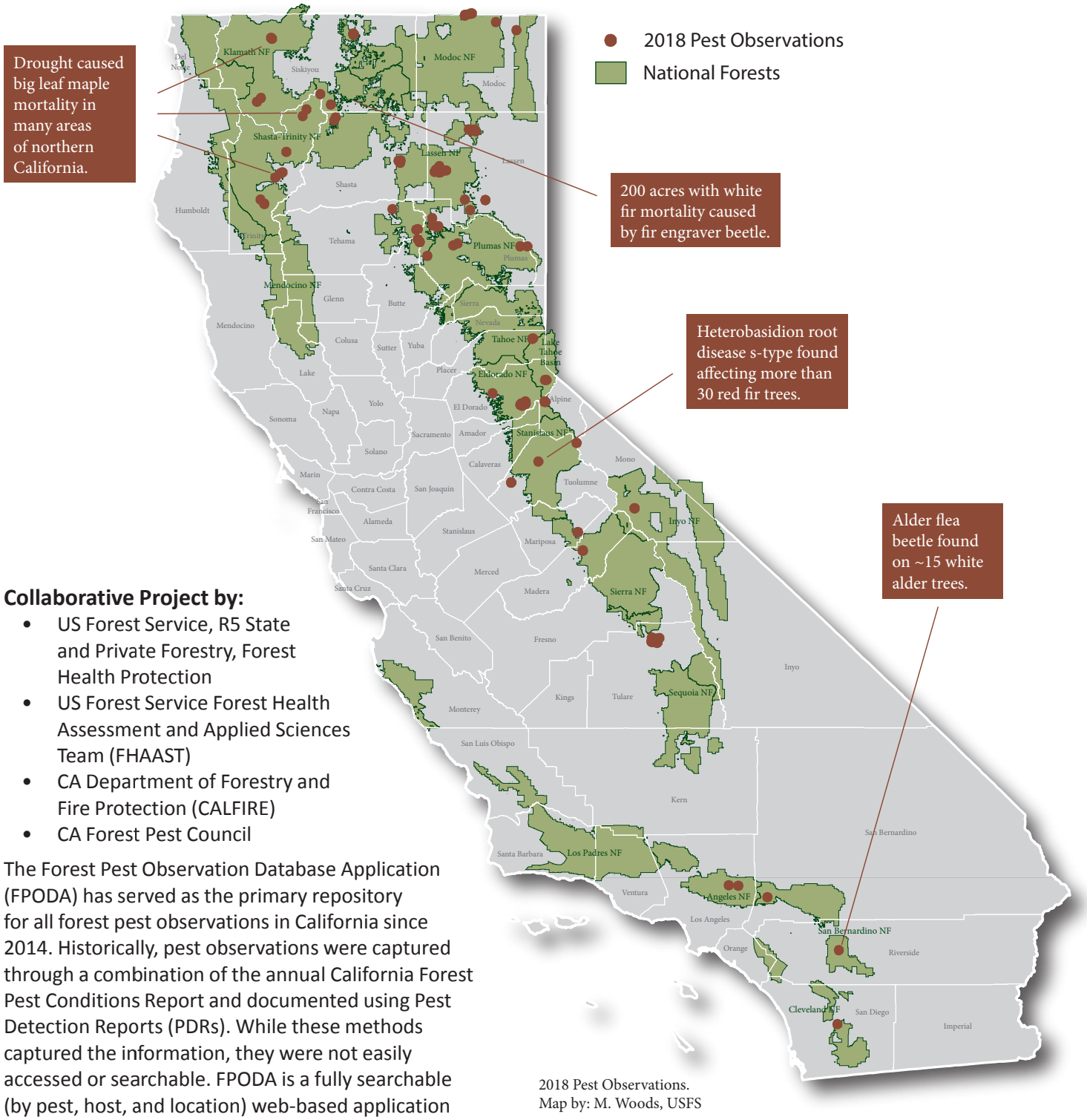
- Mortality of ~7,000 pinyon pine trees (*Pinus edulis*) attributed to pinyon ips (*Ips confusus*) was recorded primarily on the east side of the Sierra Nevada range across 700 acres.
- Douglas-fir mortality (not attributed to bear damage) increased to ~107,000 dead trees across 32,000 acres, up from ~42,000 dead trees across 18,000 acres in 2017.

Defoliation/Dieback

- Dieback and defoliation of quaking aspen (*Populus tremuloides*) was observed across 5,000 acres in the eastern Sierra Nevada range and east of the Warner Mountains (Modoc County).

Diseases

- Tanoak (*Notholithocarpus densiflorus*) mortality attributed to sudden oak death (*Phytophthora ramorum*) increased to ~1.6 million dead trees across 106,000 acres, up from ~214,000 dead trees across 18,000 acres in 2017. Mortality generally increased in extent and severity in most infested coastal areas.



2018 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 (CALFIRE)
- CA Forest Pest Council

The Forest Pest Observation Database Application (FPODA) has served as the primary repository for all forest pest observations in California since 2014. 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. FPODA is a fully searchable (by pest, host, and location) web-based application that is accessible to land managers and the public.

A new mobile pest detection data entry form was developed and released in 2018. Observations are stored in a database on ArcGIS Online (AGOL). All records from FPODA will be migrated to the new database in 2019, and FPODA will be retired. A new AGOL web app is planned for users to access and query the database.

For 2018, some records were submitted via the FPODA system, while the majority were submitted using the new mobile form. This map shows the locations of pest observations made by forest health professionals in 2018, regardless of submission method. The most frequently reported casuses of tree mortality or damage were black stain root disease, Heterobasidion root disease (s-type), and drought. Ponderosa pine, white fir, big leaf maple, and Jeffrey pine were most frequently reported as affected.

Native Insects

Douglas-fir Beetle (*Dendroctonus pseudotsugae*)
Douglas-fir beetle galleries were observed on a large section of bark from a snapped-off Douglas-fir (*Psuedotsuga menziesii*) at Azalea State Reserve near McKinleyville (Humboldt County).

Fir Engraver (*Scolytus ventralis*)
Fir engraver caused extensive mortality of at least 25 planted pole-sized white (*Abies concolor*) and red fir (*Abies magnifica*) on a property near Dinsmore, close to the Humboldt-Trinity County line. The beetles also killed 5-10 grand fir (*Abies grandis*) of all sizes (more are presumably dead in less visible areas) along 17 mi of Highway 299, between Arcata and Lord Ellis Summit, and 3 large, mature grand fir near Petrolia (Humboldt County). Beetle-related grand fir mortality also continued at Azalea State Reserve, Humboldt County (see "*Heterobasidion occidentale*" for more information), with 1-2 trees dead/acre/year over the past several years.

Fir engraver caused scattered mortality (~1-5 dead trees/acre) in mid- to high-elevation white fir in northwest California, especially in stands that were historically pine dominated. Mortality was greatest in dense stands at higher elevations on exposed dry sites or areas with Heterobasidion root disease (*Heterobasidion occidentale*). Shasta-Trinity and Klamath National Forests (Siskiyou County) had increased white fir mortality in all age classes compared to 2017 levels. White fir-dominated mixed conifer stands surrounding Juanita Lake, Klamath National Forest, had extensive mortality (25 acres with 10-50% mortality) associated with Heterobasidion root disease and fir engraver.

Mortality of white and red fir attributed to fir engraver was significantly lower across northeastern California than in 2017, except in areas where Heterobasidion root disease was severe. Scattered red fir mortality (~1 dead tree/acre) was observed near Pilot Peak, Plumas National Forest (Plumas County), and near Snow Mountain, Lassen National Forest (Butte County). Lower levels of white fir mortality (~1-2 dead trees/acre) were observed in the Warner Mountains, north of Buck Creek Work Center (Modoc County). True fir that died in 2017 retained most of their dead needles, making the determination of new versus old mortality difficult in many locations.

Fir engraver attacks were observed along the mid-sections of large white fir boles near McCloud (Siskiyou County) and in the Tahoe Basin (Placer County). The attacks were causing branch die-off in the middle of infested crowns. Approximately 100 trees were infested at each location. Many of the infested trees were also infected with Heterobasidion root disease. Most of the attacks were considered unsuccessful as there was no brood development; however, egg gallery excavations did significantly girdle tree boles.

Fir engraver activity doubled in the central and southern Sierra Nevada range, particularly in red fir in the southern

Galleries of fir engraver beetle on planted white fir near Highway 36 at the Humboldt-Trinity County border. Photo by: C. Lee, CALFIRE

White fir mortality attributed to fir engraver beetle and Heterobasidion root disease along the edge of Juanita Lake, Klamath NF. Photo by: C. Snyder, USFS

Heterobasidion occidentale conks found in white fir stumps along the edge of Juanita Lake, Klamath NF. Photo by: C. Snyder, USFS

range. The Sierra, Stanislaus, and Eldorado National Forests (Tulare, Fresno, Madera, Tuolumne, Calaveras, Amador, and El Dorado Counties) had increased red and white fir mortality in all size classes, but primarily in the 4-18 in diameter at breast height (DBH) range. White fir trees were killed where stem density was very high, while red fir saplings were often killed on exposed dry sites. Most areas with true fir mortality had common site conditions - south-facing slopes, higher elevations, or areas with root disease. In mixed conifer stands in Sequoia and Kings Canyon National Parks (Tulare County), ~20 very small trees (<6 in DBH) were found with galleries that could have been either *Scolytus ventralis* or *S. praeceps*. Dinkey Creek and Bull Creek watersheds, Sierra National Forest (Fresno County), had scattered groups of dead white fir, especially where stand densities were high (>350 ft sq/acre of basal area) or on granitic soils. At June Lake (Mono County) and in areas of Inyo County, white and red fir mortality reached 40%.

White and red fir mortality behind homes, June Lake. Photo by: H. Herrera, CALFIRE

Fir engraver and Heterobasidion root disease contributed to the mortality of white fir (~3 trees/acre over 50 acres) near Angeles Oaks, San Bernardino National Forest (San Bernardino County), as well as in Kern County, east of Cerro Noroeste, Los Padres National Forest (1-3 trees/acre over 75 acres), and along Tecuya Ridge (3-5 trees/acre over 100 acres).

Ips Engraver Beetle *(Ips* spp.)
Approximately 20 small-diameter (<6 in DBH) lodgepole pines (*Pinus contorta*) around the Lodgepole Visitor Center and campground in Sequoia and Kings Canyon National Parks (Tulare County) were heavily infested with engraver beetles (*Ips* spp.) and red turpentine beetles (*Dendroctonus valens*). Infested trees were growing next to cement crosswalks, which most likely contributed to stress and root compaction.

Small diameter lodgepole pine mass attacked by pine engraver bark beetle, Lodgepole Visitor Center, Sequoia NP. Photo by: B. Bulaon, USFS

Mountain Pine Beetle (*Dendroctonus ponderosae*)
Mountain pine beetle killed a large (>40 in DBH) sugar pine (*Pinus lambertiana*) as well as several small western white pines (*Pinus monticola*) near the summit of Horse Mountain (Humboldt County).

There was an increase in mountain pine beetle activity in whitebark pine (*Pinus albicaulis*) on the north face of Goosenest Mountain, Klamath National Forest (Siskiyou County). Mountain pine beetle has periodically caused small groups of mortality in this area (not more than 5-10 trees/group), which is often associated with blowdown and snow damage. In 2018, there were 3 groups observed with ~10-15 affected trees each.

Mountain pine beetle-caused lodgepole pine mortality increased on the Lassen National Forest and in Lassen Volcanic National Park (Lassen County). Ground checks of aerial survey data found elevated levels of lodgepole pine mortality (~2 dead trees/acre) along the upper Susan River near Silver and Caribou Lakes (Lassen County). Mortality of sugar pine was lower than previous years in all northeastern California areas. Sugar and lodgepole pine mortality caused by mountain pine beetle was lower than previous years in the southern Sierra Nevada range as well. Lodgepole pine mortality decreased (down to ~1-2 trees/acre) along Highway 168 above Tamarack Ridge and Huntington Basin and around Huntington Lake, Sierra National Forest (Fresno County), where mortality had been observed at 15-30 trees/acre previously. Eight lodgepole pines (>12 in DBH) in Lodgepole Campground and Visitor Center, Sequoia and Kings Canyon National Parks (Tulare County), were also attacked by mountain pine beetle.

Ponderosa pine with fire injury from 2018 spring prescribed burn, Greys Mountain, Bass Lake Ranger District, Sierra NF. Red turpentine beetle pitch tubes evident at the root collar and boring dust found below ground on exposed roots.
Photo by: B. Bulaon, USFS

A wind event in 2017 led to western pine beetle-caused mortality in ponderosa pine originating from wind-broken stems, Shasta-Trinity NF. Photo by: C. Snyder, USFS

Red Turpentine Beetle (*Dendroctonus valens*)

Red turpentine beetle adults were observed in dying bishop pines (*Pinus muricata*) at Van Damme, Russian Gulch, and MacKerricher State Parks (Mendocino County). One dead tree was examined per park; however, bishop pine (*Pinus muricata*) mortality was much more extensive in the area (see "Root-Feeding Bark Beetles; *Hylurgops porosus*" for more information).

Red turpentine beetle was the most frequently observed bark beetle (in number of pitch tubes noted and prevalence) attacking pines in the southern Sierra Nevada range in 2018. Approximately 35 scattered ponderosa (*Pinus ponderosa*) and Jeffrey pines (*Pinus jeffreyi*), averaging ~13 in DBH, had numerous attacks in a mixed pine plantation south of Dinkey Creek Road, Sierra National Forest (Fresno County). This activity was near western pine beetle-caused ponderosa pine mortality that occurred in 2015 and 2016. Red turpentine beetle also attacked charred boles of pines (as high up as 15 ft) along Sky Ranch Road, within the 2017 Railroad Fire (Mariposa County). Red turpentine beetle activity was detected on more than half of the ponderosa and sugar pines in a 2018 prescribed spring burn on Greys Mountain, Sierra National Forest (Mariposa County). Red turpentine beetle attacks were also noted just under the duff layer on the roots of fire-injured trees.

Western Pine Beetle (*Dendroctonus brevicomis*)

Ponderosa pine mortality caused by western pine beetle was scattered across the low- to mid-elevations of northwestern California, often concentrated in wildfire- and storm-damaged areas. An increase in western pine beetle attacks on boles of wind-snapped pines and non-injured pines was observed following a wind event on the west side of the Shasta-Trinity National Forest (Trinity County). The blowdown covered ~10 acres. Groups of tree mortality (5-10 trees/group) also occurred in overstocked pine plantations growing on lower elevation ridges on the east side of the Mendocino National Forest, north of the Mendocino Complex (Glenn and Tehama Counties).

Western pine beetle-caused mortality remained at background levels throughout most of northeastern California; however, increasing mortality was detected in a couple of locations. Several groups of ponderosa pine (5-30 trees/group) were killed near the Buck Creek Work Center in the northern Warner Mountains and west of Goose Lake, Modoc National Forest (Modoc County). Many of the group kills that have occurred

Ponderosa pines killed by western pine beetle, Bass Lake, Sierra NF. Photo by: B. Bulaon, USFS

Large diameter western pine beetle-killed ponderosa pines adjacent to Kings River, High Sierra Ranger District, Blue Canyon, Sierra NF. Photo by: B. Bulaon, USFS

Bark beetle infestation near Crestline, San Bernardino County. Photo by: H. Herrera, CALFIRE

west of Goose Lake over the past few years consist of older, fire-injured trees within the 2012 Barry Point Fire perimeter. Single trees and small groups of ponderosa pine (3-5 trees) were killed around Pine Creek Valley and Grays Valley, Lassen National Forest (Lassen County), and near Boca Reservoir, Tahoe National Forest (Nevada County).

In the southern Sierra Nevada range, western pine beetle continued to kill individual ponderosa pines in areas where activity has been detected since 2016. On the Stanislaus National Forest (Tuolumne County), native stands in the 4,000-5,000 ft elevation band experienced losses of 1-3 trees near large groups of trees killed during the recent drought. Ponderosa pine mortality on the Bald Mountain lava ridge, Stanislaus National Forest, occurred in trees with thin crowns or in those that were growing on the driest sites (Tuolumne County). Around Bass Lake (Madera County), large ponderosa pines were attacked and killed in groups of 2-3 trees. Groups of mature ponderosa pines killed by western pine beetle were also observed in the Kings River watershed (Fresno County). Pines growing in and along Big Creek in Blue Canyon that had survived the drought were attacked in 2018.

Western pine beetle and *Ips* spp. killed ponderosa pine (~10 trees/acre over more than 50 acres) near Jenks Lake. Western pine beetle also killed single trees and pockets of 10-15 ponderosa and Coulter pines (*Pinus coulteri*) north of Crestline along Highway 138 (San Bernardino County). Coulter pine mortality (1-2 trees/acre over 25 acres) from western pine beetle also occurred west of Wrightwood (Los Angeles County).

Invasive Insects

Asian Gypsy Moth (*Lymantria dispar asiatica*, a subspecies of European Gypsy Moth)

One Asian gypsy moth (AGM) was found in Santa Cruz (Santa Cruz County) in August in a pest detection trap. This catch was ~1/3 mi from the single AGM catch in 2017. In response to the 2017 detection, a 5-mi radius, 100-sq mi delimitation trapping array was put in place. A total of 1,084 traps were installed with the intent to detect the presence and extent of any infestation. An AGM Technical Working Group was convened in September, 2017. No treatments have occurred as a result of these 2 finds over the past 2 years.

European Gypsy Moth (*Lymantria dispar*)

One European gypsy moth male was trapped in July in Orange County. There were also 9 instances of various European gypsy moth life stages being detected at border inspection stations on articles entering the state.

Goldspotted Oak Borer (*Agrilus auroguttatus*)

Los Angeles County

Since 2015, the Angeles National Forest and Los Angeles County have been working with the Green Valley community to contain the goldspotted oak borer (GSOB) infestation via infested tree removal. Inspections of 6,226 coast live oaks in Green Valley identified 1,551 GSOB-infested trees on private property. Surveys for GSOB on the Angeles National Forest around Green Valley resulted in the confirmation of 112 acres of infested coast live oaks. Ten trees were removed around the Green Valley Community

Center in 2018; 82 trees were removed in 2017. An estimated 100 trees have more than 25 exit holes and are slated for removal in 2019. Along with removing highly infested trees, the Angeles National Forest plans to spray ~400 coast live oaks with insecticides to prevent GSOB attacks. Several trainings and outreach events have also been conducted to inform the Green Valley community about GSOB and the impacts of moving infested firewood.

One dead coast live oak with GSOB injury was discovered in Bouquet Canyon, ~9 miles from the Green Valley infestation. This is believed to be a new introduction and not natural spread from Green Valley. Plans to delimit the Bouquet Canyon area are underway (GSOB Quarterly Situation Report, 2018).

GSOB-infested coast live oak near Blue Jay Campground, Trabuco Ranger District, Cleveland NF. Photo by: S. Hishinuma, USFS

Coast live oak mortality caused by GSOB near Lake Henshaw, San Diego County. Photo by: S. Hishinuma, USFS

Orange County

In late 2017, GSOB was detected for the first time on the Trabuco Ranger District, the most northern district of the Cleveland National Forest. GSOB-related injury was highest on large-diameter coast live oaks between Falcon and Blue Jay Campgrounds. Less than 10% of trees were infested at both sites.

GSOB was newly detected in 2018 in Gypsum Canyon, northeast of the current infestation in Weir Canyon. Ground surveys, removal of highly infested trees, and insecticides were being used to slow its spread in coast live oak throughout the area (GSOB Quarterly Situation Report, 2018).

Riverside County

On the San Bernardino National Forest, San Jacinto Ranger District, GSOB has been detected as far north as Pine Cove and as far south as Keen Camp Summit (north of Lake Hemet). A positive trap find occurred near the El Cariso Fire Station and campground along Highway 74; however, no infested trees were identified.

San Bernardino County

GSOB was discovered for the first time in Oak Glen in late October; this is believed to be another introduction of GSOB via long-distance firewood movement.

San Diego County

GSOB has caused elevated levels of coast live oak (*Quercus agrifolia*) mortality on the Palomar and Descanso Ranger Districts, Cleveland National Forest, for over 10 years. To prevent additional mortality, the Palomar Ranger District treated 256 uninfested or lightly infested high-value coast live oaks at 4 sites: Oak Grove Campground, Oak Grove Fire Station, Inaja Memorial Picnic Area, and Pine Hills Fire Station near Julian.

GSOB was detected for the first time in Felicita Park, Daley Ranch Park (Escondido), and Los Penasquitos Canyon County Preserve (City of San Diego).

Invasive Shot Hole Borers (*Euwallacea* sp.) and associated **Fusarium Dieback** (*Fusarium* sp.)

Polyphagous shot hole borer (PSHB; 1 of 2 known invasive shot hole borers - ISHBs) is established in Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties and continued to cause mortality in urban forests. Kuroshio shot hole borer (KSHB; second known ISHB) is now present in 4 counties: Los Angeles, Orange, Santa Barbara, and San Diego.

Los Angeles and San Bernardino Counties

Polyphagous shot hole borer was widespread (3-5% of host trees were infested) along the base of the Angeles National Forest and spreading north into Big Tujunga, Santa Anita, Pasadena Glen, and Eaton Canyons.

Orange County

An estimated 50,000 trees were infested by ISHB in large regional and wilderness Orange County parks. Beetles were also present in all turf parks, with infestation rates ranging from 1-888 trees per park by late 2017 (Invasive Shot-Hole Borer Survey Results, Cycle 2 [2017]). Approximately 75% of infested trees had low to moderate levels of attacks (<50 holes with no dieback to 50-150 holes with no dieback) and 15% were heavily infested (>150 holes with and without evident dieback). Higher trap catches occurred near residential areas (Southern California Forest Pest Council update, 10-9-2018, Beatriz Nobua Behrmann). A new infestation was identified at Crystal Cove State Park, Laguna Beach. Modjeska Canyon Nature Preserve is now the only ISHB-free park in the county.

Invasive shot hole borers were detected for the first time in 2018 on the Cleveland National Forest. One beetle was found in a trap at the base of Trabuco Canyon, adjacent to O'Neill Regional Park.

San Diego County

Invasive shot hole borers were detected for the first time in 2018 on the Cleveland National Forest. Seventy percent of *Salix* species and approximately 5% of California sycamores (*Platanus racemosa*) were attacked in the riparian forest below El Capitan Reservoir (San Diego River). Following the detection in the San Diego River watershed, a volunteer citizen science trapping program resulted in additional detections between Mission Valley and Lakeside.

Santa Barbara County

Invasive shot hole borer infestations continued in Montecito and Lotus Land. KSHB spread in San Ysidro Creek also continued, and a new infestation of KSHB was found along Sycamore Canyon Road.

Ventura County

The 3,500-acre Hedrick Ranch Nature Area and surrounding lands are riparian floodplains dominated by *Salix* species that continue to be infested with PSHB. PSHB was first detected at this site in 2016, when it was found in small, localized infestations. Based on general observations, as well as data from 9, 30-m radius monitoring plots throughout the affected area, the number of trees infested by PSHB at this location increased substantially from 2017 to 2018. In 2017, the proportion of the trees affected by PSHB was 0.27, compared to 0.49 in 2018. Tree species affected included arroyo willow (*Salix lasiolepis*), red willow (*Salix laevigata*), California sycamore (*Platanus racemosa*), black cottonwood (*Populus trichocarpa*), Fremont cottonwood (*Populus fremontii*), and white alder (*Alnus rhombifolia*). Symptoms included beetle entry holes, staining, exudate, boring dust, and canopy dieback. No trees have died due to ISHB/*Fusarium* sp. in the monitoring plots; however, mortality has occurred outside the plots that may be attributed to the pest-disease complex.

UC Santa Barbara continued trapping in riparian areas in the Santa Clara River watershed, where PSHB continued to spread along the Santa Clara River and in the Ventura River corridor.

Grand fir bole infested by balsam woolly adelgids at Van Damme State Park, Mendocino County. Photo by: C. Lee, CALFIRE

Introduced Insects (Naturalized)

Balsam Woolly Adelgid (*Adelges piceae*)

Extensive stem infestations by balsam woolly adelgid were detected on 4 grand firs (*Abies grandis*) in the town of Gualala and on 1 grand fir in the upper loop of Van Damme State Park (Mendocino County). All stem-infested grand firs were 6-12 in DBH. Little crown damage was observed at the grand fir stand in Gualala (although many branches had substantial growth of sooty mold), but the surrounding stand at Van Damme exhibited severe branch curling in the upper crowns as well as generalized crown dieback in larger, older trees. Balsam woolly adelgid infestations north of Fort Bragg (Mendocino

County) and in Fortuna (Humboldt County) were also causing increased levels of crown damage and mortality of larger trees (approximately 2-5 dead trees/acre/year).

White Satin Moth (*Leucoma salicis*)
Several stands of aspen (*Populus tremuloides*) in the Lake Tahoe Basin were defoliated by the white satin moth. Stands of defoliated trees were found near the communities of Homewood (Placer County), Meyers, Taylor Creek, and Fallen Leaf Lake (El Dorado County).

Other Highlights

Alder Bark Beetle (*Alniphagus aspericollis*)
Attacks by alder bark beetles resulted in mortality in stands of red alder (*Alnus rubra*) in Topanga Canyon (Los Angeles County), Point Reyes National Seashore (Sonoma County), along Pescadero and Arroyo de los Frijoles Creeks (San Mateo County), and San Pedro Creek, Pacifica (San Mateo County). A few scattered dead trees were also found in the Cosumnes River Preserve (Sacramento County). The number of dead trees at each site ranged from a half dozen to several hundred. Affected trees also appeared to have a fungus (*Diatrypella pulvinata*) in the insect galleries. This fungus is not normally associated with alder bark beetles and may be contributing to mortality. This fungus was previously only reported on dead oak and beech branches in central and eastern Europe and more recently on dead oak branches in Washington.

Ambrosia Beetles (*Trypodendron* spp., *Gnathotrichus* spp.)
Ambrosia beetles were found attacking several fire-injured white fir (*Abies concolor*) as well as neighboring unscorched white fir on the Sierra National Forest within the 2018 Ferguson Fire (Mariposa County). Ambrosia beetles were also observed in large red firs (*Abies magnifica*) (15 trees, >30 in DBH) slightly north of Beasore Meadows along Beasore Road (Madera County). Mass attacked trees had high levels of boring dust and declining crowns. A few additional red firs were also attacked by ambrosia beetles, but only up to 5 in above ground line on tree boles.

Ambrosia beetle boring dust collecting at the base of a mature red fir tree along Beasore Road, Bass Lake Ranger District, Sierra NF. Photo by: B. Bulaon, USFS

Black Pineleaf Scale (*Nuculaspis californica*)
Black pineleaf scale caused needle dieback on over 75 ponderosa (*Pinus ponderosa*) and Jeffrey pines (*Pinus jeffreyi*) in Bear Valley Springs (Kern County). Trees were growing along a road where dust accumulates, a common factor related to black pineleaf scale infestations. This scale has previously been detected at this location.

California Flatheaded Borer (*Phaenops californica*)
Mortality associated with California flatheaded borer was observed in both ponderosa and Jeffrey pine in northeastern California on extremely poor growing sites, in trees with heavy western dwarf mistletoe (*Arceuthobium campylopodum*) infection, and in trees associated with root disease pockets. One area with Jeffrey pine mortality (~10 dead trees) was found near Lake Almanor (Plumas County) within a Heterobasidion and blackstain root disease (*Leptographium wageneri*) pocket. Jeffrey pine mortality (~2 dead trees/acre) occurred in a few isolated areas near Susanville, within the Bureau of Land Management Eagle Lake Resource Area (Lassen County). Dead pines appeared to have been repeatedly attacked for 2-3 years by borers since the drought.

A couple groups of dead mature Jeffrey pines (4-5 trees) were found around the Breckenridge Mountain housing tract, Sequoia National Forest (Kern County), amidst younger Jeffrey

Small diameter ponderosa pines killed by woodborers in a meadow that had dried out during the recent drought event, Calaveras Ranger District, Stanislaus NF. Photo by: B. Bulaon, USFS

pine in plantations. These larger trees (>25 in DBH) were killed by California flatheaded borer over the past year. Two nearby small trees (<10 in DBH) were also killed. Ten ponderosa pines (averaging 8 in DBH) were also killed by California flatheaded borers within a young plantation near Avery, Stanislaus National Forest (Calaveras County). These trees were in a meadow and were likely stressed from a low water table.

California flatheaded borer and *Ips* spp. killed ~20 Jeffrey pines over more than 2 acres along the Angeles Crest Highway west of Wrightwood (Los Angeles County). Jeffrey pine mortality caused by California flatheaded borer and *Ips* spp. also occurred east of Cerro Noroeste (8-10 trees/acre over more than 200 acres) and along Tecuya Ridge (5-10 trees/acre over more than 300 acres) on the Los Padres National Forest (Kern County).

California Oak Moth (*Phryganidia californica*)
Large numbers of California oak moth adults were observed swarming around coast live oak (*Quercus agrifolia*) trees on the Monterey peninsula (Monterey County), possibly signaling an upcoming defoliation event.

Erineum Mite (*Eriophyes mackiei*)
Hundreds of canyon live oak trees (*Quercus chrysolepis*) scattered around Weimar (Placer County) were attacked by the erineum mite. Affected trees were almost completely defoliated, but were expected to recover as new leaves emerged. No other oak species in the area appeared to be affected.

Redwood Bark Beetle (*Hylurgops porosus*)
Redwood bark beetle infestations were found in a group of large, 120-year-old coast redwoods (*Sequoia sempervirens*) at Redwood Park, Arcata (Humboldt County). Two of the redwoods were dead and at least 3 others exhibited boring dust and pitch droplets on the boles. The infestation appeared to be related to extensive waterlogging of the root zone from a neighborhood water leak earlier in 2018.

Redwood bark beetle galleries on the root crown of coast redwood, Arcata, Humboldt County. Photo by: C. Lee, CALFIRE

Root-Feeding Bark Beetles (*Hylurgops porosus*)
Root-feeding bark beetles were found colonizing a dead bishop pine (*Pinus muricata*) at Van Damme State Park (Mendocino County). This bark beetle typically colonizes severely stressed or moribund pines. Adults of the red turpentine beetle were found at the base of the same tree. The same beetle assemblage was also observed on dying pines at Russian Gulch and MacKerricher State Parks, near Fort Bragg (observed on 1 pine at each location, but dead pines were numerous).

Twohorned Oak Gall Wasp (*Dryocosmus dubiosus*)
Leaves on coast live oak trees in Felicita Park (San Diego County) were showing signs of infestation by the twohorned oak gall wasp. Trees attacked by the gall wasp were declining from other causes prior to attack. Leaves infested with this gall wasp often discolor and die. Trees were not infested with GSOB.

Fusarium Diseases

Fusarium avenaceum

Fusarium avenaceum continued to cause leader mortality, stunting, and reduction of current-year needles on over 100, 10-15 ft tall Jeffrey pines (*Pinus jeffreyi*) as well as a few planted ponderosa pines (*Pinus ponderosa*) near Dinsmore, close to the Humboldt-Trinity County line. Additionally, a *Fusarium* closely related to *F. avenaceum* or *F. tricinctum* was isolated from 10-12 rapidly dying Monterey pine (*Pinus radiata*) seedlings beneath mature declining Monterey pine at the Fernbridge exit of Highway 101 near Ferndale (Humboldt County).

Pitch Canker (*Fusarium circinatum*)

Pitch canker caused increased branch flagging and tree mortality in bishop pine (*Pinus muricata*) and, to a lesser extent, shore pine (*Pinus contorta*) along the Sonoma County coast, from the mouth of the Russian River northward. Damage was most pronounced around the community of Timber Cove, Salt Point State Park, and around Stewarts Point. In 2017, the northernmost extent of pathogen symptoms was 10 mi north of the Sonoma-Mendocino County line, near Iverson Road. In 2018, symptoms occurred a few miles north of Iverson Road; however, testing was not conducted to confirm *F. circinatum* was the causal agent. In western Marin County, new pitch canker symptoms were widespread, although they appeared less dramatic against the backdrop of already dead stems from previous years' infections.

Development of pitch canker in shore and bishop pines near Iverson Road, Mendocino County. In the center of each picture is the same tree (newly dead in 2017 (above), gray skeleton in 2018 (below)). Photos by: C. Lee, CALFIRE

Fusarium oxysporum

Fusarium oxysporum was isolated from necrotic areas of feeder roots in a group of ~6 mature coast redwood (*Sequoia sempervirens*) trees with severely thinning crowns near Soquel (Santa Cruz County). Another 15-20 large redwoods in the area showed similar symptoms. *Phytophthora cryptogea* was baited from rhizosphere soils in the decline area, and a *Diaporthe* species was isolated from the symptomatic redwood roots.

F. oxysporum was also detected in root crown cankers and lower stems causing considerable post-emergence mortality of ~100 Douglas-fir (*Pseudotsuga menziesii*) seedlings at the L.A. Moran Reforestation Center, Davis (Yolo County).

Symptoms of damping-off caused by *Fusarium oxysporum* on Douglas-fir seedlings, L.A. Moran Reforestation Center, Yolo County. Photo by: C. Lee, CALFIRE

Phytophthora Species and Other Oomycete Pathogens

Elongisporangium undulatum (previously *Phytophthora undulata*)

Elongisporangium undulatum was baited from soil underneath a group of dead, mature coast redwood (*Sequoia sempervirens*) trees in Arcata (Humboldt County) (see "Redwood Bark Beetle" for more information). A water line break in the vicinity kept the soil saturated for several months, potentially increasing pathogen inoculum levels. Previously named *Pythium undulatum* and *Phytophthora undulata*, the pathogenicity of this microbe on redwood is unknown and under investigation.

Dead and dying tanoaks associated with *Phytophthora cinnamomi*-infested soil, Jackson Demonstration State Forest near Caspar, Mendocino County. Photo by: C. Lee, CALFIRE

Phytophthora cinnamomi

Phytophthora cinnamomi and a second, unknown *Phytophthora* species were baited from soil beneath 5 acres of dead and declining Pacific madrones (*Arbutus menziesii*) near Boulder Creek (Santa Cruz County). The unknown species was 99% identical to both *P. cactorum* and *P. pseudotsugae*. These results match those obtained in 2017 from soil baited beneath declining tanoaks (*Notholithocarpus densiflorus*) and madrones at Mount Madonna (Santa Cruz County).

Phytophthora cinnamomi was baited from soil along a popular hiking, biking, and horse riding trail in Jackson Demonstration State Forest (Mendocino County). The stand encompassed 10-20 acres where tanoak, chinquapin (*Chrysolepis* sp.), and bishop pine (*Pinus muricata*) were dying.

Phytophthora cryptogea

Phytophthora cryptogea was baited from soil beneath ~12 severely declining coast redwood trees in Soquel State Demonstration Forest (Santa Cruz County) (see "*Fusarium oxysporum*" for more information).

Dead Port-Orford-cedar at Fish Lake resistance test site, Six Rivers NF. Photo by: P. Angwin, USFS

Port-Orford-Cedar Root Disease *(Phytophthora lateralis)*

Two small tributaries of Sultan Creek in the Smith River watershed, north of Crescent City (Del Norte County), had numerous dead Port-Orford-cedars (*Chamaecyparis lawsoniana*). Along 2, 500-m informal survey lines, approximately 50-70 dead trees of all size classes were observed. Almost all trees had been dead for at least several months, with only a little gray foliage remaining. Bear damage was responsible for most of the mortality. However, at least a third of the trees had no bear damage and were extensively mined by cedar bark beetles (*Phloeosinus* sp.). Of the 2 trees examined that still had live foliage, both had resinosis at the base and necrotic cankers were observed in the cambium. Samples taken from 1 of the trees yielded a *Phytophthora* species similar to *P. lateralis*. Samples from both trees have been submitted for DNA analysis.

Twelve Port-Orford-cedars died in 2018 at the 4 Port-Orford-cedar root disease test sites on the Six Rivers National Forest (Humboldt and Del Norte Counties), down from 40 dead trees in 2017. Genetic tests at Oregon State University will determine how many of the 12 died from *P. lateralis*. Six of the 40 trees that died in 2017 had the pathogen.

Visual monitoring revealed no new infected Port-Orford-cedar near the *P. lateralis* eradication treatment site at Scott Camp Creek on the Shasta-Trinity National Forest (Siskiyou County). First detected in 2001 and treated in 2004-2005, the pathogen has not been detected in or around the eradication zone since 2008.

Phytophthora pseudocryptogea

Phytophthora pseudocryptogea caused coast live oak (*Quercus agrifolia*) stress and dieback on a 20-acre parcel in Santa Barbara County. Of the more than 200 overcrowded oaks on the property, approximately 10% exhibited bleeding cankers and thinning crowns.

Phytophthora pseudocyrptogea on coast live oak, Santa Barbara County. Photo by: K. Corella, CALFIRE

Sudden Oak Death (*Phytophthora ramorum*)

The US Forest Service Aerial Detection survey documented a large increase in tanoak mortality related to sudden oak death (SOD) from Big Sur (Monterey County) up through Humboldt County (see "Aerial Detection Survey" for more information). Most of the wildland mortality was likely the result of pathogen spread during the 2016-2017 winter, which had above-average precipitation in many coastal areas (see examples in Table 1).

Table 1. Examples of above-average precipitation in coastal counties, 2016-2017.

Location	County	Average Yearly Precipitation	Precipitation 11/16 - 6/17
Ben Lomond	Santa Cruz	50.52	84.99
Bodega	Marin	40.83	48.26
Santa Rosa	Sonoma	30.98	43.56
Garberville	Humboldt	68.78	70.44

In contrast, results from the 2018 "SOD Blitz" citizen science survey reported generally less prevalent infection incidence in 2018 in the wildland-urban interface (WUI). Of the trees sampled, 3.5% were infected with *P. ramorum*, a threefold drop in the rate of new infections in 2017. Several areas with trees positive in 2017 were not found positive in 2018, including Golden Gate Park and the Presidio of San Francisco (San Francisco County), the UC Berkeley campus (Alameda County), and Mount Diablo State Park (Contra Costa County). Increasing mortality seen in 2018, despite lower infection incidence, is accounted for by noting the typical 2-3-year lag between tree infection and mortality, whereas the SOD Blitz monitors current infection on California bay laurel (*Umbellularia californica*) and tanoak.

The SOD Blitz noted new outbreaks in several urban areas, including parts of Alameda and Marin Counties, southern Mendocino County near Yorkville, the city of Napa (Napa County), parts of Santa Clara County, Boulder Creek (Santa Cruz County), and cities in inland Sonoma County. Two *P. ramorum*-infected bay trees were also found for the first time in the Salmon Creek watershed near the border of Salmon Creek in southern Monterey County, where the pathogen had previously only been detected in creek water.

In the southern SOD range, extensive tanoak mortality (up to 3,000 ft in elevation, on ridgetops) was observed in Big Sur (Monterey County), as were extensive areas of symptomatic coast live oak (indicating heightened mortality is expected). Pervasive tanoak mortality was observed throughout the Santa Cruz Mountains (Santa Cruz County), beginning with smaller trees early in 2018 and progressing to larger trees as water deficits increased throughout summer.

On the north side of the San Francisco Bay, tanoak and manzanita (*Arctostaphylos* spp.) mortality was widespread on Mount Tamalpais (Marin County), even in areas with no bay trees. In the Timber Cove/Fort Ross area (Sonoma County), SOD and pitch canker (*Fusarium circinatum*) were both present and causing extensive mortality of tanoaks and pines (Monterey and bishop), respectively. The Coast Range (Sonoma County) and inland southern Humboldt County also had widespread *P. ramorum*-related mortality, and the pathogen was causing new, discrete mortality centers near Piercy and within Jackson Demonstration State Forest (Mendocino County).

In Humboldt County, *P. ramorum* was detected (via stream baiting) for the first time since 2015 in Chadd Creek (a tributary to the Eel River that flows along the Avenue of the Giants near the community of Redcrest), and it was found for the first time in Yager Creek (a tributary to the Van Duzen River). Disease expansion was also recorded south and upstream of the original infestation along the Mad River; along Stover Road, south (upstream) of the original Redwood Valley infestation; and along Mattole Canyon Creek in southwestern Humboldt, from the expanding Mattole watershed infestations. In far northern Humboldt County, the aerial survey detected extensive spread upriver along Redwood Creek within Redwood National Park, at the edges of previous management areas, where attempts to slow the spread have stopped. Despite the proximity of this infestation to Del Norte County, no infected wildland trees have been found there.

SOD Blitz results documenting a minimal increase in infection in 2018 were reflected in north coast (Sonoma, Mendocino, and Humboldt Counties) surveys, which had minimal *P. ramorum* recovery in bay leaves. While symptomatic tanoak leaves and twigs continued to yield the pathogen reliably (even during the summer months), surveys using bay leaves in the north coast were largely unsuccessful, likely due to generally dry conditions.

First reports of *P. ramorum* causing mortality or leaf and branch dieback were documented on the following *Arctostaphylos* species in 2018: Montara (*Arctostaphylos montaraensis*), Boony Doon (*A. silvicola*), Monterey or Toro (*A. montereyensis*), Sandmat (*A. pumila*), La Panza or Santa Margarita (*A. pilosula*), Morro (*A. morroensis*), and Santa Lucia manzanita (*A. hooverii*). Koch's postulates were either completed or are in progress for each host. The infected plants were found at the UC Santa Cruz Arboretum (Santa Cruz County).

Phytophthora spp. – First Reports in California

Phytophthora crassamura was found attacking coffeeberry (*Frangula californica*) in San Mateo County. Symptoms included root dieback, mortality, and lack of regeneration in restoration sites and disturbed areas. The pathogen was also found in restoration sites on other species (*Artemisia douglasiana*, *Diplacus aurantiacus*, *Rosa californica*, *Salix* sp., *Sambucus mexicana*, and others) in Santa Clara County.

Phytophthora megasperma was found in Marin County causing a 10-m diameter area root disease center with root dieback and stem lesions on sticky monkeyflower (*Diplacus aurantiacus*) in a restoration site.

Phytophthora multivora was found on blueblossom ceanothus (*Ceanothus thyrsiflorus*) and coffeeberry in San Francisco and San Mateo Counties. Symptoms included mortality, root dieback, and stem lesions. This was the first report of the disease in North America.

Phytophthora pseudocryptogea was found attacking Arroyo willow (*Salix lasiolepis*), blueblossom ceanothus, and sticky monkeyflower in Marin County. Symptoms included mortality, stunted growth, root dieback, stem lesions, and lack of regeneration in restoration sites and disturbed areas.

Phytophthora taxon kelmania was found attacking coffeeberry and sticky monkeyflower in Marin and San Francisco Counties. Symptoms included mortality, root dieback, and stem lesions in restoration sites and disturbed areas.

Rusts

White Pine Blister Rust (*Cronartium ribicola*)

White pine blister rust (WPBR) was evident in sugar pine (*Pinus lambertiana*) seedlings along the length of the South Grove trail in Calaveras Big Trees State Park (Calaveras County). The pathogen was causing branch flagging and significant mortality of saplings.

White pine blister rust was observed on whitebark pine (*Pinus albicaulis*) and western white pine (*P. monticola*) near Carson Pass (Alpine County). Infested western white pines with bole cankers did not produce cones. Lower branches were alive, but branches above the canker were sterile.

A survey of a high-density, legacy sugar pine stand at Cold Springs (Tuolumne County) showed a regeneration rate of over 500 seedlings/acre. However, many of the seedlings showed indications of blister rust infection.

Surveys conducted in Bear Valley Mountain, Double Mountain, Sawmill Canyon, Summit Lime Company lands, and Loop Ranch (Kern County) found no evidence of WPBR. Based on the findings, Breckenridge (Kern County) is still considered to be the southern extent of WPBR in California.

White pine blister rust canker on dead sugar pine sapling, Calaveras Big Trees State Park, Calaveras County.
Photo by: C. Lee, CALFIRE

Stem and Trunk Diseases

Alder Mortality

Red (*Alnus rubra*) and white alder (*Alnus rhombifolia*) mortality was observed in stands of ~12 to several hundred trees in locations ranging from Topanga Canyon (Los Angeles County) in southern California to Point Reyes (Marin County) in northern coastal California. Trees were also impacted in interior areas, such as the Cosumnes River Preserve (Sacramento and San Joaquin Counties). One of the most heavily impacted areas was around Pacifica (San Mateo County). Tree decline and mortality there was associated with numerous bleeding cankers on boles and branches, most of which originated at beetle entrance holes at branch junctions. Alder bark beetle (*Alniphagus aspericollis*) adults were recovered from the cankered areas and several fungi were recovered from the stained sapwood around the cankers. Many of the fungi are considered weak, or secondary pathogens or decayers. Fungi recovered included *Diplodia mutila*, *Diatrypella pulvinata* (see alder bark beetle under Insect Section for more information), *Phoma exigua*, *Diaporthe eres*, and *Ophiostoma quercus*.

Willow Branch Dieback
(*Botryosphaeria dothidea, B. parva,* and *B. obtusa*)
Samples collected in Orange County from 3 native willow species (*Salix lasiolepis*, *S. laevigata*, and *S. gooddingii*) with wilted branches, necrotic foliage, and associated dark brown, sunken cankered wood tissues were found positive for *Botryosphaeria dothidea*, *B. parva*, and *B. obtusa*.

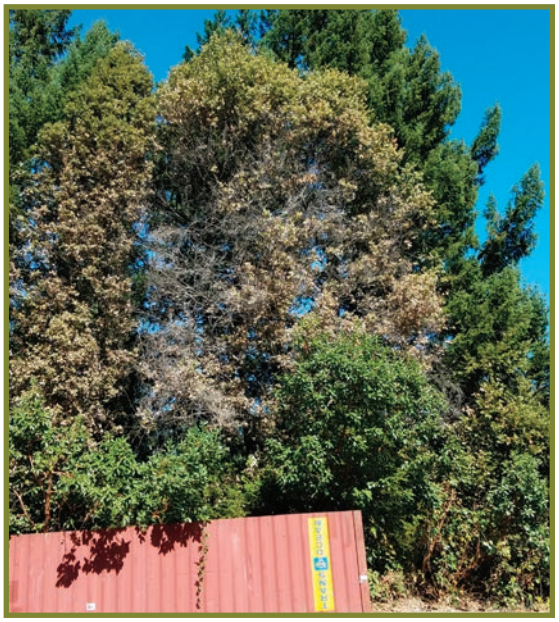
Needle dieback on coast redwood caused by Botryosphaeriaceae. Photo by: S. Latham, CDFA

Crown dieback on coast redwoods caused by Botryosphaeriaceae. Photo by: S. Latham, CDFA

***Botryosphaeria* Canker**
(*Botryosphaeria dothidea* and *Neofusicoccum* spp.)
Coast redwoods (*Sequoia sempervirens*) grown outside of their native range as urban and shade trees are susceptible to drought, sunburn, and infection from opportunistic fungal pathogens, including some members of the fungal family Botryosphaeriaceae. More than 100 samples from redwood trees exhibiting branch and needle dieback were collected from 11 coastal and central California locations over a 6-year period. Botryosphaeriaceae were isolated from more than 50% of the samples, with 5 different species confirmed. In addition to *Botryosphaeria dothidea*, which was previously regarded as the primary pathogen on coast redwoods, 4 species of *Neofusicoccum* were also confirmed: *Neofusicoccum australe*, *N. luteum*, *N. mediterraneum*, and *N. parvum*. Although not previously documented on coast redwood in California, these *Neofusicoccum* species have a very wide host range and cause canker diseases worldwide, including on many native, non-native, and agricultural woody hosts in the state. These species appear to be more virulent than *B. dothidea* as cankers on redwoods inoculated with each of the 4 *Neofusicoccum* species grew faster than those inoculated with *B. dothidea*. *N. australe* caused the largest lesions, followed by *N. luteum*, *N. parvum*, and *N. mediterraneum*. Although coast redwoods are generally regarded as disease tolerant, when grown out of their natural range and in stressful environments, they are susceptible to infection by multiple Botryosphaeriaceae canker fungi.

Diplodia Diseases
A *Diplodia* species (likely *D. corticola*) was isolated from a couple of tanoaks (*Notholithocarpus densiflorus*) with extensive branch dieback just east of Salyer on Highway 299 near the Humboldt-Trinity County line. Tanoaks affected by this pathogen, and the pathogen *Tubakia californica*, have been evident for several years in the area between Burnt Ranch and Salyer to the east and Lord-Ellis Summit to the west (Humboldt County). *D. corticola* was also isolated from a group of tanoak saplings with branch dieback. In some saplings, complete mortality occurred on a 0.5 mi stretch of road north of Bridgeville (Humboldt County). In the upper loop of Van Damme State Park (Mendocino County), samples taken from 3 dead tanoaks (with leaves still attached) and nearby tanoaks exhibiting branch dieback yielded a *Botryosphaeria* canker pathogen that strongly resembled a *Diplodia* species.

Roadside gray pines (*Pinus sabiniana*) were infested with *Diplodia pinea* along 10 mi of Highway 20, near Wilbur Hot Springs, to the end of the Coast Range foothills near Williams (Colusa County). The same pathogen caused tip dieback in roadside ponderosa pines along Highway 299 from Del Loma to Weaverville (Trinity County).



Typical symptoms associated with *Diplodia corticola* and *Tubakia californica* on tanoak along Highway 299, Humboldt and Trinity Counties. Photo by: C. Lee, CALFIRE

Diplodia scrobiculata was consistently recovered from seedling- and sapling-size dead and dying Monterey (*Pinus radiata*) and shore pines (*Pinus contorta*) in northern coastal California counties (Sonoma, Mendocino, and Humboldt). A 15 ft-tall Monterey pine was infested with the pathogen in Sea Ranch (Sonoma County), and ~100 Monterey pine seedlings were infested at the California Coastal National Monument along Highway 1, north of Point Arena (Mendocino County). Approximately 12 dying Monterey pine saplings were infested with the pathogen at the Fernbridge exit of Highway 101 near Ferndale (Humboldt County), as was a shore pine sapling on the campus of College of the Redwoods, Eureka (Humboldt County). In this smaller-sized material, this pathogen caused black vascular discoloration that extended across entire stems (similar to a vascular wilt pathogen) and was often associated with bark beetle galleries.

(Left) Monterey pine seedlings killed at the California Coastal National Monument along Highway 1 north of Point Arena, Mendocino County. (Right) Vascular discoloration caused by *Diplodia scrobiculata* in the dead seedlings. Photos by: C. Lee, CALFIRE

Drought-stressed coast live oaks (*Quercus agrifolia*) in Topanga Canyon and Tapia, Malibu Creek State Park (Los Angeles County), are being infected by *Diplodia* canker. Of the 41 plots being monitored for the disease, 25% of the 299 coast live oaks surveyed (covering 6.3 acres) were infected.

Foamy Bark Canker (*Geosmithia pallida*)
Foamy bark canker was found attacking over 12 California black oaks (*Quercus kelloggii*) around a pond in Wilton (Sacramento County). Stressed by the draining of the pond 2 seasons in a row, the trees were also being attacked by the western oak bark beetle (*Pseudopityopthorus pubipennis*).

Raffaelea montetyi (first report of occurrence in the US)
Severely declining and dead valley oak (*Quercus lobata*) trees near Calistoga (Napa County) had dark vascular discoloration. The trees were colonized by ambrosia beetles (*Monarthrum scutellare*), and *Raffaelea montetyi* was isolated from the infected trees. This is the first report of this fungus in the US.

Big leaf maple with maple leaf scorch along Highway 96 and the Klamath River, Siskiyou County. Photo by: W. Woodruff, USFS

Foliar Diseases

Maple Leaf Scorch
Maple leaf scorch (MLS) on big leaf maple (*Acer macrophyllum*) was found along many of the highways reported with MLS in previous Forest Pest Conditions reports (Highways 3, 36, 50, 70, 89, 96, and 299 as well as Interstate 5). Up to 50% of maples observed had MLS symptoms on most of their foliage. Many maples that have had heavy MLS symptoms for many years now have dead branches in the upper crowns. The cause of MLS is not known, but a bacterium is suspected.

Marssonina Leaf Blight (*Marssonina populi*)
Marssonina leaf blight caused minor defoliation of quaking aspen (*Populus tremuloides*) on the eastern side of the Warner Mountains in the Dismal Swamp area, Modoc National Forest (Modoc County).

Pestalotiopsis Disease (*Pestalotiopsis funerea*)
Pestalotiopsis funerea was causing browning of foliage on 6 large-diameter incense cedars (*Calocedrus decurrens*) in Meadow Vista (Placer County). The discoloration was largely superficial. The trees are expected to make a full recovery.

Quaking aspen with Marssonina leaf blight near Dismal Swamp, Modoc NF. Photo by: W. Woodruff, USFS

Pine Needle Cast (*Lophodermella* sp.)
Approximately 50 large ponderosa pines (*Pinus ponderosa*) impacted by pine needle cast throughout Paradise (Butte County) looked completely brown or dead; however, new needle growth was green and healthy. Affected trees are expected to make a full recovery.

Powdery Mildew (*Erysiphe quercicola*)
Blue oaks (*Quercus douglasii*) in eastern Napa County were found to have severe powdery mildew, often leading to epicormic branching and witches' broom. Some trees were exhibiting severe decline or mortality. This is the first report of this fungus in the US.

Fruiting bodies of *Heterobasidion occidentale* in a white fir stump near Juanita Lake, Goosenest Ranger District, Klamath NF, Siskiyou County.
Photo by: P. Angwin, USFS

Fruiting bodies of *Heterobasidion occidentale* in a white fir stump in the Three Springs project area, Klamath NF, Siskiyou County. Photo by: P. Angwin, USFS

Powdery Mildew
(*Microsphaera penicillata*)
Powdery mildew turned blue oaks nearly white around Alta Sierra (Nevada County). Approximately 10 affected trees were scattered throughout the community. Many lost their leaves early. The trees are expected to recover.

Root Diseases

Armillaria sp.

Armillaria was killing ~20 small white fir (*Abies concolor*) seedlings along the South Grove trail in Calaveras Big Trees State Park (Calaveras County). Evidence of infection, particularly basal resinosis, was seen in most of the mature white fir trees along the trail.

Black stain root disease in the xylem of a Douglas-fir at the Classic Site, Happy Camp Ranger District, Klamath NF, Siskiyou County. Photo by: P. Angwin, USFS

Heterobasidion Root Disease (*Heterobasidion occidentale*)
Heterobasidion root disease continued to contribute to deterioration and slow death of grand fir (*Abies grandis*) scattered through a 5-acre section of a stand at Azalea State Reserve near McKinleyville (Humboldt County). Humid conditions at the park, and all along the coast, were favorable for this pathogen, as exposed fruiting bodies were easily observed at the bases of infected trees. Fir engraver beetle (*Scolytus ventralis*) also contributed to grand fir mortality in widely scattered root disease centers, and adelgids suspected to be balsam woolly adelgid (*Adelges piceae*) were collected from fir stems.

Heterobasidion root disease (*Heterobasidion occidentale*) and fir engraver beetle (*Scolytus ventralis*) caused widespread groups (3-30+ trees) of dead and dying white fir in a 200-acre mixed-conifer stand on the northwest and west sides of Juanita Lake, Goosenest Ranger District, Klamath National Forest (Siskiyou County). Mortality has been ongoing since at least 2005, but has increased substantially over the past several years. Heterobasidion root disease and fir engraver beetle also caused scattered white fir mortality in a 200-acre mixed conifer stand in the Three Springs project area, Goosenest Ranger District, Klamath National Forest (Siskiyou County). *Heterobasidion occidentale* fruiting bodies were identified in several white fir stumps.

Black Stain Root Disease (*Leptographium wageneri*)
Black stain root disease was detected in individual declining and dead mature Douglas-fir (*Pseudotsuga menziesii*) trees (1-5 dead trees/acre over 40+ acres) as well as in several larger disease centers along the northeast face of Bear River Ridge near Ferndale (Humboldt County).

Widespread Douglas-fir mortality was noted on approximately 15 acres of the native stand surrounding the sugar pine (*Pinus lambertiana*) progeny test site on the Happy Camp Ranger District, Klamath National Forest (Siskiyou County).

Black stain root disease did not cause any new mortality in 2018 in the high-elevation areas of the Inyo National Forest, White Mountains (Inyo County). The 40-acre stand surveyed was in an area where the disease had been very active in recent years, causing decline in some of the ancient bristlecone pines (*Pinus longaeva*). Findings suggest environmental conditions may not be favorable for disease persistence at this location.

Black stain root disease in ponderosa pine, central Modoc County. Photo by: W. Woodruff, USFS

Black stain root disease-infected ponderosa pine near the Oregon border. Photo by: W. Woodruff, USFS

Mistletoes

White Fir Dwarf Mistletoe (*Arceuthobium abietinum* f. sp. *concoloris*)
The combined impacts of white fir dwarf mistletoe, Cytospora canker (*Cytospora abietis*), fir engraver beetle (*Scolytus ventralis*), and drought caused flagging and mortality of several hundred white firs (*Abies concolor*) along a 5-mi stretch of USFS Road 40N08 in the East Fork Scott River project area, Scott River Ranger District, Klamath National Forest (Siskiyou County).

White fir dwarf mistletoe on white fir along USFS Road 40N08, East Fork Scott River project area, Klamath NF. Photo by: P. Angwin, USFS

True mistletoe in dead Baker cypress, Lassen NF. Photo by: W. Woodruff, USFS

True Mistletoe
(*Phoradendron densum*)
Most of the Baker cypress (*Hesperocyparis bakeri*) was in decline or dead on ~5 acres of mixed-conifer forest in the Whittington Project Area on the Hat Creek Ranger District, Lassen National Forest (Lassen County). Many of the mature cypress were heavily parasitized by true mistletoe. Moisture stress caused by a combination of drought, mistletoe, and competing trees, along with overstory shading, were thought to have caused the death and decline. *Heterobasidion*-like root decay was collected from an uprooted cypress snag and is being analyzed to confirm presence of the root disease. Another nearby small stand of Baker cypress (burned in the Eiler Fire in 2014) was being reforested with healthy cypress seedlings sourced from cones in the Baker cypress canopy. Baker cypress is endemic to a small area across far northern California and southwestern Oregon. It is found in northeastern California on ~7,500 acres.

Green Algae

Trentophila (*Trentophila aurea*)
A green alga was found growing on the trunk and understory branches of ~12 Monterey cypress (*Hesperocyparis macrocarpa*) trees at Pismo State Beach (San Luis Obispo County). The filaments of *Trentophila* are orange because of the presence of large quantities of carotenoid pigments, which mask the green chlorophyll. *Trentophila* are typically found growing in humid environments.

Trentophila on Monterey cypress, San Luis Obispo County. Photo by: K. Corella, CALFIRE

Drought

High levels of coast live oak (*Quercus agrifolia*) mortality continued in localized areas of Talega Canyon and the hotel training area of Camp Pendleton (Orange County). Drought and oak ambrosia beetle (*Monarthrum* spp.) were suspected to be the cause of the die off. No invasive insects or root diseases were found.

In Topanga (Los Angeles County), hundreds of oaks (*Quercus* spp.) had leaf dieback in July due to ongoing drought conditions and extreme daytime temperatures (up to 115° F) and hot night temperatures (up to 95° F). Other tree species had similar symptoms.

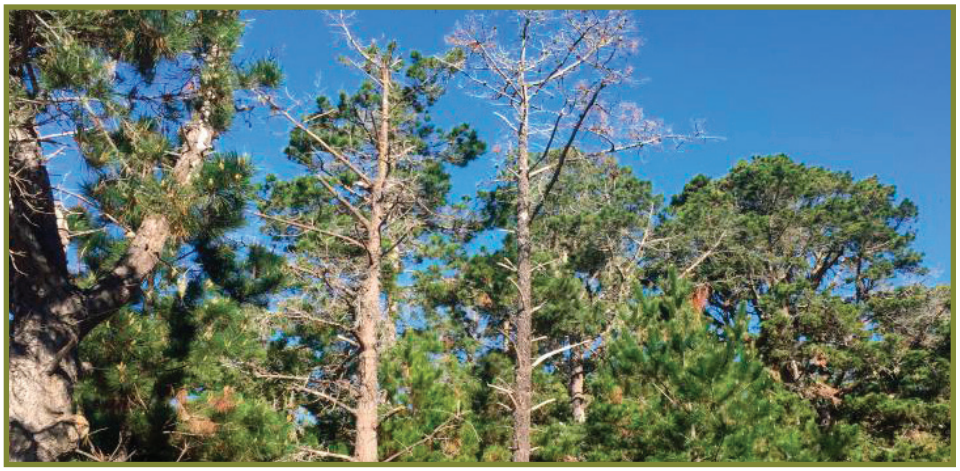
Abiotic and biotic factors caused mortality in overmature Monterey pines (*Pinus radiata*) in a 690-acre forest in Carmel Highlands, Carmel-by-the-Sea, and a 400-acre forest in Point Lobos State Natural Reserve (Monterey County). The recent drought, pitch canker (*Fusarium circinatum*), red turpentine beetles (*Dendroctonus valens*), pine engraver beetles (*Ips paraconfusus*), and pine sawflies (*Neodiprion* spp.) were contributing factors for 40% of the mortality, with drought considered to be the primary cause.

Tree and limb mortality occurred on the Audubon Starr Ranch (4,000 acres) in southeast Orange County. At least 12 trees or major limbs failed due to drought and possible heart rot. Coast live oak and western sycamore (*Plantanus racemosa*) were the main species affected.

Abiotic and biotic influences caused increased tree dieback and/or mortality in Santa Barbara County, where an upsurge in drought-stressed trees caused an influx of wood-boring beetles (most likely ambrosia beetles). Main symptoms included flagging and/or significant canopy dieback or complete tree mortality of previously healthy trees. Mortality was seen over ~30 acres at El Capitan State Beach, Refugio State Beach, and Carpinteria State Beach. Eucalyptus (*Eucalyptus* sp.), cypress (*Hesperocyparis macrocarpa*), pine (*Pinus* spp.), coast live oak, and myoporum (*Myoporum parvifolium*) were affected. Impacted tree habitats included riparian, chaparral, and beach/dunes. Drought and insect-stressed trees have become prominent in the area over the last several years.

Coast live oak dieback near Camp Pendleton, Orange County. Photo by: K. Corella, CALFIRE

Coast live oak dieback, Topanga Canyon, Los Angeles County. Photo by: R. Dagit, Resource Conservation District, Santa Monica Mountains



Monterey pine dieback, Point Lobos State Natural Reserve, Monterey County. Photo by: F. Ono, F. O. Consulting

Coast live oak mortality, Audubon Starr Ranch, Orange County. Photo by: S. DeSimone, Audubon Starr Ranch Sanctuary

Incense cedars (*Calocedrus decurrens*) continued to decline in areas that had suffered severe pine mortality during the recent drought. Areas on the Sierra National Forest, such as lower Kings River Watershed, High Sierra Ranger District (Fresno County), and Bass Lake, Bass Lake Ranger District (Madera County), around 3,500 ft in elevation, had dying cedars in stands where pines had been previously killed.

Impact of the Carr Fire, Redding, Shasta County. Photo by: P. Angwin, USFS

Wildfires

Wildfires devastated forests, homes, communities, and infrastructure throughout California in 2018. Trees of all species were killed or seriously injured in wildfires. Fire-injured trees that are not killed often become more susceptible to various insects and diseases. In 2018, an estimated 1,671,203 acres of California forests and woodlands burned in wildfires (http://cdfdata.fire.ca.gov/incidents/incidents_stats?year=2018, accessed March 21, 2019). These fires were some of the largest, deadliest, and most damaging on record, including fires in Butte and Lake Counties and around Redding, Yosemite National Park, and Malibu. The area burned during the comparable period in 2017 was 1,248,606 acres.

Black Bears (*Ursus americanus*) Extensive tree damage and mortality caused by bears was noted on 50-70 Port-Orford-cedar trees (*Chamaecyparis lawsoniana*) on a property in the Sultan Creek drainage (Del Norte County). Although trees of all sizes were affected, smaller trees (10-20 in diameter) were most often killed.

Squirrels (*Sciurus griseus*) Western gray squirrels killed the tops of a row of 5, 25-40 ft tall coast redwood trees (*Sequoia sempervirens*) near Arcata (Humboldt County).

Damage by bears to young Port-Orford-cedar, Del Norte County. Photo by: C. Lee, CALFIRE

Damage by squirrels on young redwoods, Humboldt County. Photo by: C. Lee, CALFIRE

RISK OF INSECT AND DISEASE SPREAD

Firewood remained a potential source for the introduction and spread of pests into California from other parts of the country as well as within the state. On June 3, 2018, a trailer from Illinois was stopped at the Benton Border Station (Mono County) with 100 lbs of firewood with insect holes and noticeable pest damage. The wood was confiscated, split open to confirm pest presence (several live ants were recovered), and then properly disposed of for violating California FAC Section 6461.5 (live pests). Collected insects were identified as a Q-rated *Camponotus sp*. (carpenter ant) and a Q-rated *Temnothorax sp*. (ant). The Q-rating by the California Department of Food and Agriculture means the organisms are suspected of being of economic importance, but since they are not yet in California, their potential impact is unknown.

Goldspotted oak borer was discovered for the first time in Oak Glen (San Bernardino County) in late October; this is believed to be another introduction via long-distance firewood movement.

Continuing Work on New Biocontrols

The following updates are based on descriptions and initial work first reported on insect biocontrols for giant reed (arundo, *Arundo donax*), Cape ivy (*Delairea odorata*), and Scotch broom (*Cytisus scoparius*) in the 2016 and 2017 California Forest Pest Conditions Reports.

Arundo wasp (*Tetramesa romana*)

The arundo wasp deposits its eggs into the main and lateral shoot tips of arundo (*Arundo donax*) where the eggs and developing larvae induce gall formation. Over time, galling by the wasp reduces live biomass by killing side stems and young main stems. Surveys were conducted in San Diego, Santa Barbara, and Ventura Counties in 2018 to assess distribution of the wasp. It was found in low densities across all counties, and its distribution did not appear to differ substantially from previous surveys conducted in 2006-07. Surveys will be conducted over a larger geographic area in 2019.

The arundo wasp. Photo by: J. Goolsby, USDA ARS

Arundo armored scale (tentatively assumed to be *Rhizaspidiotus donacis*)

The arundo armored scale attacks developing underground buds of arundo on the rhizome near the soil surface and at the base of lateral shoots, resulting in gradual thinning of infested arundo stands over time. The arundo scale was first released in California in 2015 and was confirmed as established at several sites in northern California by 2017. Surveys were conducted in San Diego, Santa Barbara, and Ventura Counties in 2018 to assess distribution of the scale. As with prior surveys, it was only found in the Santa Clara River watershed (Ventura County). Monitoring in additional southern California watersheds for this recently detected insect is ongoing. Several thousand scales were collected from the Santa Clara River watershed to determine genetics, emergence rates, and parasitoid presence. Arundo plants were inoculated with crawlers and transferred to field locations to evaluate methods for implementing mass field releases. Researchers at UC Santa Barbara are developing mass rearing techniques for this scale.

Galls on Cape ivy caused by Cape ivy fly.
Photo by: S. Portman, USDA ARS

Cape ivy shoot tip-galling fly (*Parafreutreta regalis*)

Introduced into California in 2016 to help control Cape ivy (*Delairea odorata*), this fly lays its eggs inside the plant's growing shoot tips. The plant forms galls in response to egg deposition and larval feeding. The larvae mature in the gall. Experimental lab results (prior to field release of the fly) showed a 50% reduction in biomass and size of fly-infested Cape ivy plants. Field releases in southern California at Toro Canyon Park (Santa Barbara County) in September 2018 were successful, with galls forming within 2 weeks on affected plants. These results contrasted with releases in 2016 at same site that failed to produce any galls or fly establishment, likely due to drought conditions. Researchers at UC Santa Barbara are developing mass rearing techniques for this fly.

European Scotch broom gall mite (*Aceria genistae*)

Although never approved for release in the United States, this gall mite has become established in California and causes the formation of numerous galls on attacked Scotch broom (*Cytisus scoparius*) plants. High gall densities result in stem dieback. Genetic and morphological assessments completed in 2018 verified that the gall mite collected in California is *A. genistae*. A USDA Animal and Plant Health Inspection Service (APHIS) Technical Advisory Group for Biological Control Agents of Weeds (TAG) Petition is in development. The TAG petition is a key official step in gaining approval to further distribute this biological control agent.

Galls on Scotch broom caused by European Scotch broom gall mite.
Photo by: P. Pratt, USDA ARS

New Invasive Plants

At the 2018 California Invasive Plant Council meeting, the California Department of Food and Agriculture reported on several plant species that may be emerging as issues in the state. One of the plants discussed is of concern in wildlands - star endive or endive daisy (*Rhagadiolus stellatus*). This annual herb, a member of the Asteraceae family, grows in partial shade and has a unique star-shaped fruit. Star endive was found spreading in forest understories in Solano and Napa Counties and appeared to be the dominant plant growing in those areas, especially in coast live oak (*Quercus agrifolia*) forests, where the star endive has developed into dense patches (tens of thousands of stems). Although it is a slow spreader, it appears to grow well along roadsides (perhaps because of available additional nitrogen), growing as high as 1-2 ft/year. Elsewhere it generally grows less than 6 in in height annually. Star endive has the potential to spread throughout California's coastal oak woodlands.

Endive daisy. Photo by: R. Spellenberg, CalPhotos

In 2018, scientific publications concerning California forest pests and wildland conditions included:

Aram, K. and Rizzo, D.M. 2018. Distinct trophic specializations affect how *Phytophthora ramorum* and Clade 6 *Phytophthora* spp. colonize and persist on *Umbellularia californica* leaves in streams. Phytopathology. 108(7): 858-869.

Della Rocca, G.; Danti, R.; Popenuck, T.; Di Lonardo, V.; and Garbelotto, M. 2018. Resistance to cypress canker disease in Italian cypress has desirable effects on disease epidemiology, but may fail against novel genotypes of the pathogen *Seiridium cardinale*. Forest Ecology and Management. 424: 259-266.

DeSiervo, M.H.; Jules, E.S.; Bost, D.S.; De Stigter, E.L.; and Butz, R.J. 2018. Patterns and drivers of recent tree mortality in diverse conifer forests of the Klamath Mountains, California. Forest Science. 64(4): 371–382.

Elliott, M.; Yuzon, J.; Tripathy, S.; Bui, M.; Chastagner, G.A.; Coats, K.; Rizzo, D.M.; Garbelotto, M.; and Kasuga, T. 2018. Characterization of phenotypic variation and genome aberrations observed among *Phytophthora ramorum* isolates from diverse hosts. BMC Genomics. 19(1): 320.

Fettig, C.J. 2018. Socioecological impacts of the western pine beetle outbreak in southern California: Lessons for the future. Journal of Forestry. doi.org/10.1093/jofore/fvy029.

Fettig, C.J.; Lowrey, L.L.; Blackford, D.C.; McMillin, J.D.; Munson, A.S.; and Mortenson, L.A. 2018. Efficacy of spring and fall treatments of carbaryl for protecting ponderosa pine from mortality attributed to mountain pine beetle (*Coleoptera: Curculionidae*). Journal of Economic Entomology. 111: 2979–2982.

Frankel, S.J.; Alexander, J.A.; Benner, D.; and Shor, A. 2018. Responding to inadvertent *Phytophthora* introductions in California restoration areas. California Agriculture. 72(4): 205-207.

Furniss, M.M. 2018. The battle for old-growth ponderosa pine in northeastern California: Efforts to control the western pine beetle in remnant old-growth stands during the 1920s. American Entomologist. 64(1): 16–19.

Gabriel, M.W.; Diller, L.V.; Dumbacher, J.P.; Wengert, G.M.; Higley, J.M.; Poppenga, R.H.; and Mendia, S. 2018. Exposure to rodenticides in northern spotted and barred owls on remote forest lands in northwestern California: Evidence of food web contamination. Avian Conservation and Ecology. 13(1): 2. https://doi.org/10.5751/ACE-01134-130102.

Garbelotto, M.; Frankel, S.J.; and Scanu, B. 2018. Soil- and water-borne *Phytophthora* species linked to recent outbreaks in northern California restoration sites. California Agriculture. 72(4): 208-216.

Gazis, R.; Poplawski, L.; Klingeman, W.; Boggess, S.L.; Trigiano, R.N.; Graves, A.D.; Seybold, S.J.; and Hadziabdic, D. 2018. Mycobiota associated with insect galleries in walnut with thousand cankers disease reveals a potential natural enemy against *Geosmithia morbida*. Fungal Biology. 122: 241-253.

Hacker, G.M.; Brown, R.N.; Fedorova, N.; Girard, Y.A.; Higley, M.; Clueit, B; and Lane, R.S. 2018. Spatial clustering of *Borrelia burgdorferi* sensu lato within populations of Allen's chipmunks and dusky-footed woodrats in northwestern California. PLOS ONE 13(4): e0195586. https://doi.org/10.1371/journal.pone.0195586.

Hartmann, H.; Moura, C.F.; Anderegg, W.R.; Ruehr, N.K.; Salmon, Y.; Allen, C.D.; and others. 2018. Research frontiers for improving our understanding of drought-induced tree and forest mortality. New Phytologist. 218(1): 15-28.

He, Y.; Chen, G.; De Santis, A.; Roberts, D.A.; Zhou, Y.; and Meentemeyer, R.K. 2019. A disturbance weighting analysis model (DWAM) for mapping wildfire burn severity in the presence of forest disease. Remote Sensing of Environment. 221: 108-121.

Hefty, A.R.; Aukema, B.H.; Venette, R.C.; Coggeshall, M.V.; McKenna, J.R.; and Seybold, S.J. 2018. Reproduction and potential range expansion of walnut twig beetle across the Juglandaceae. Biological Invasions. 20: 2141-2155. https://doi.org/10.1007/s10530-018-1692-5.

Hood, S.M.; Cluck, D.R.; Jones, B.; and Pinnell, S. 2018. Radial and stand-level thinning treatments: 15-year growth response of legacy ponderosa and Jeffrey pine trees. Restoration Ecology. 26: 813-819.

Hood, S.M.; Varner, M.; van Mantgem, P.; and Cansler, C.A. 2018. Fire and tree death: Understanding and improving modeling of fire-induced tree mortality. Environmental Research Letters. 13: 113004.

Hunter, S.; Williams, N.; McDougal, R.; Scott, P.; and Garbelotto, M. 2018. Evidence for rapid adaptive evolution of tolerance to chemical treatments in *Phytophthora* species and its practical implications. PlOS ONE. 13(12): e0208961.

McCartney, M.M.; Roubtsova, T.V.; Yamaguchi, M.S.; Kasuga, T.; Ebeler, S.E.; Davis, C.E.; and Bostock, R.M. 2018. Effects of *Phytophthora ramorum* on volatile organic compound emissions of rhododendron using gas chromatography–mass spectrometry. Analytical and Bioanalytical Chemistry. 410(5): 1475-1487.

Morris, J.L.; Cottrell, S.; Fettig, C.J.; Hansen, W.D.; Sherriff, R.L.; Carter, V.A.; Clear, J.; Clement, J.; DeRose, R.J.; Hicke, J.A.; Higuera, P.E.; Mattor, K.M.; Seddon, A.W.R.; Seppä, H.; Stednick, J.D.; and Seybold, S.J. 2018. Bark beetles as agents of change in social-ecological systems. Frontiers of Ecology and the Environment. 16(S1): S34–S43.

Oren, E.; Klingeman, W.; Gazis, R.; Moulton, J.; Lambdin, P.; Coggeshall, M.; Hulcr, J.; Seybold, S.J.; and Hadziabdic, D. 2018. A novel molecular toolkit for rapid detection of the pathogen and primary vector of thousand cankers disease. PLOS ONE. 13(1): e0185087.

Seybold, S.J.; Bentz, B.J.; Fettig, C.J.; Lundquist, J.E.; Progar, R.A.; and Gillette, N.E. 2018. Management of western North American bark beetles with semiochemicals. Annual Review of Entomology. 63: 407-432.

Simler, A.B.; Metz, M.R.; Frangioso, K.M.; Meentemeyer, R.K.; and Rizzo, D.M. 2018. Novel disturbance interactions between fire and an emerging disease impact survival and growth of resprouting trees. Ecology. 99(10): 2217-2229.

Sims, L.L. and Garbelotto, M. 2018. Susceptibility to the rare *Phytophthora tentaculata* and to the widespread *Phytophthora cactorum* is consistent with host ecology and history. Forest Pathology. DOI: 10.1111/efp.12446.

Sims, L.; Tjosvold, S.; Chambers, D.; and Garbelotto, M. 2018. Control of *Phytophthora* species in plant stock for habitat restoration through best management practices. Plant Pathology. DOI: 10.1111/ppa.12933.

Steel, Z.L.; Koontz, M.J.; and Safford, H.D. 2018. The changing landscape of wildfire: Burn pattern trends and implications for California's yellow pine and mixed conifer forests. Landscape Ecology. 3(7)3: 1159–1176. https://doi.org/10.1007/s10980-018-0665-5.

Stephens, S.L.; Collins, B.M.; Fettig, C.J.; Finney, M.A.; Hoffman, C.E.; Knapp, E.E.; North, M.E.; and Safford, H. 2018. Drought, tree mortality, and wildfire in forests adapted to frequent fire. Bioscience. 68: 77–88.

Swiecki, T.J.; Bernhardt, E.A.; and Frankel, S.J. 2018. *Phytophthora* root disease and the need for clean nursery stock in urban forests. Part 1. *Phytophthora* invasions in the urban forest and beyond. Western Arborist. 54-62.

Tonini, F.; Jones, C.; Miranda, B.R.; Cobb, R.C.; Sturtevant, B.R.; and Meentemeyer, R.K. 2018. Modeling epidemiological disturbances in LANDIS-II. Ecography. 41: 1–7.

Tooley, P.W. and Browning, M. 2018. Sporangia production over time by *Phytophthora ramorum* on Rhododendron 'Cunningham's White' after placement at different relative humidities. Phytopathology. 108(6): 721-729.

Vernon, M.J.; Sherriff, R.L.; van Mantgem, P.; and Kane, J.M. 2018. Thinning, tree-growth, and resistance to multi-year drought in a mixed-conifer forest of northern California. Forest Ecology and Management. 422: 190-198.

Vose, J.M.; Peterson, D.L.; Domke, G.M.; Fettig, C.J.; Joyce, L.A.; Keane, R.E.; Luce, C.H.; Prestemon, J.P.; Band, L.E.; Clark, J.S.; Cooley, N.E.; D'Amato, A.; and Halofsky, J.E. 2018. Forests. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R.; Avery, C.W.; Easterling, D.R.; Kunkel, K.E.; Lewis, K.L.M.; Maycock, T.K.; and Stewart, B.C. (eds.)]. U.S. Global Change Research Program, Washington, DC, USA. DOI: 10.7930/NCA4.2018.CH6.

Widmer, T.L.; Tooley, P.W.; and Camp, M.J. 2018. Recovery of *Phytophthora ramorum* in plant tissue with mixed infections. European Journal of Plant Pathology. 150(1): 253-258.

Zielinski, W.J. and Gray, A.N. 2018. Using routinely collected regional forest inventory data to conclude that resting habitat for the fisher (*Pekania pennanti*) in California is stable over ~20 years. Forest Ecology and Management. 409: 899-908.

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.

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Cover Photo
Ponderosa pines killed by western pine beetle, Bass Lake, Sierra NF.
Photo by: B. Bulaon, USFS

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