USDA Forest Service
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Major Forest Insect and Disease Conditions in the United States 2019

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Acknowledgements

The annual forest conditions report provides information generated through the combined efforts of U.S. Department of Agriculture (USDA), Forest Service employees; State agencies; and other partners. Their dedication to the monitoring, detection, suppression, treatment, and management of our forested lands for insects and disease makes this report possible.

Report compiled by S. Sky Stephens, Sheryl A. Romero, and Frank J. Krist (USDA Forest Service, Forest Health Protection).

Photo credit

Cover photo: Mountain pine beetle infestation showing recently killed and fading lodgepole pine. Photo by Whitney Cranshaw, Colorado State University, Bugwood.org

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This report and other Forest Health Protection materials can be found online at:
https://www.fs.usda.gov/foresthealth

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703–605–5344

USDA Forest Service
Northern Region (R1)
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200 East Broadway
P.O. Box 7669
Missoula, Mt 59807–7669
406–329–3308

USDA Forest Service
Rocky Mountain Region (R2)
1617 Cole Boulevard, Building 17
Lakewood, CO 80401
303–275–5350

USDA Forest Service
Southwestern Region (R3)
333 Broadway Boulevard, SE
Albuquerque, NM 87102
505–842–3247

USDA Forest Service
Intermountain Region (R4)
324 25th Street
Ogden, UT 84401
801–625–5759

USDA Forest Service
Pacific Southwest Region (R5)
1323 Club Drive
Vallejo, CA 94592
707–562–8921

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Portland, OR 97204–3440
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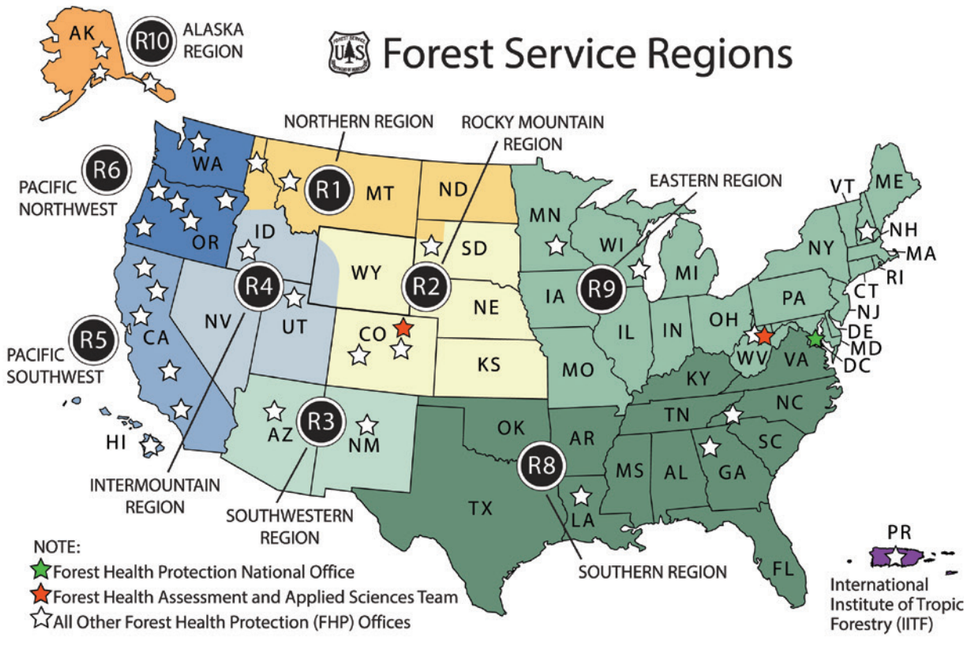


Preface

This report on the major insect and disease conditions of the Nation's forests represents the 69th annual report prepared by the U.S. Department of Agriculture, Forest Service. The report focuses on major insects and diseases that annually impact our Nation's forests. This 2019 update provides a national summary of the major changes and status of major forest pests with updated charts, tables, and maps. Additional information on these and other pests is available at: https://www.fs.usda.gov/foresthealth/.

The information in this report is provided by the Forest Health Protection program of the Forest Service and its State partners. This program serves all Federal lands, including National Forest System lands, lands administered by the U.S. Departments of Defense and the Interior, and Tribal lands. The program also provides assistance to private landowners through State foresters and other State agencies. Key elements of the program are administered by Forest Service and State program specialists to detect and report insect and disease epidemics through annual detection and monitoring surveys.

For additional information about forest health conditions, contact a Forest Service office (see map for office coverage) or your State Forester.

Contents

IMPORTANT: *When interpreting maps throughout this document, note that data are displayed at the county scale only. For example, if damage was reported at just one location in the county, the entire county is displayed as affected. This standard convention is used because data for most pests are collected only at the county level. If the damage were reported at finer scales, many areas would not be visible at the scale used in this publication. The maps represent only what is reported as mortality or defoliation and not the total infestation of a particular pest. In any given year, some areas are not surveyed due to physical limitations, such as forest fires, weather events, or limited resources. Data collected from ground and aerial surveys used in this report represent a single snapshot in time for a given year. More frequent surveys are conducted in specific areas on a case-by-case basis. By combining these surveys over time, this report captures general trends and conditions of selected insects and diseases across multiple years.*

Introduction

2.7 MILLION ACRES
of mortality to white, red, and grand fir

38 PERCENT
of total tree mortality caused by fir engraver

1.3 MILLION ACRES
of mortality caused by emerald ash borer

Insects and diseases play critical roles in maintaining healthy, resilient ecosystems. They also can be among the most serious economic and environmental threats to the forests and urban landscapes in the United States. Trees respond to environmental cues and may be positively or negatively impacted by these changes, altering ecosystem services derived from forested lands, including timber, recreation, tourism, clean water, energy, wildlife habitat, and jobs. To understand how conditions are changing and to protect species, forests are surveyed for insect and disease extent and intensity on an annual basis. Federal and State agencies and other stakeholders work together to use this information for management to ensure resilient forests are sustainable into the future. The overall mortality caused by insects and diseases varies by year and by pest.

TREE MORTALITY

In 2019, more than **7.1 million acres** of tree mortality were caused by insects and diseases in the United States, which is approximately 1.1 million acres more than reported in 2018. In forests across the Western United States, tree mortality by the fir engraver accounted for **38 percent** of total mortality observed in 2019, causing approximately **2.7 million acres** of mortality to white, red, and grand fir. The emerald ash borer accounted for **1.3 million acres** of mortality.

Spruce beetle and sudden oak death were also important contributors to tree mortality in our Nation's forests in 2019.

Every year, hundreds of native and nonnative insects and diseases damage our Nation's forests. This report provides descriptions of major insects and diseases that contribute to annual tree mortality and damage. Additionally, the "Feature" section describes pests that the Forest Service and its partners are closely monitoring. While each pest is reported separately, multiple pests may be active in the same area causing mortality to multiple host trees, magnifying the change in forest condition and creating complex forest management challenges.

For more information on all the mortality and damage agents please visit: https://www.fs.usda.gov/foresthealth/.

In addition to mortality, defoliating pests can damage trees by eating leaves or needles, causing significant losses of foliage and altering forest health. A single defoliation event does not usually cause tree mortality; taken together with repeated attacks or severe abiotic factors, such as weather and drought, trees can succumb to these defoliating insects or be predisposed to other insects and disease impacts. In 2019, surveys recorded **5.4 million acres** of defoliation and other types of damage agents.

2019 HIGHLIGHTS OF TREE MORTALITY AND OTHER DAMAGE FROM INSECTS AND DISEASES

Approximately **500 million acres** surveyed annually

7.1 MILLION ACRES WITH DEAD TREES

5.4 MILLION ACRES WITH OTHER TREE DAMAGE

SUDDEN OAK DEATH
OAK AND TANOAK
- Kills several oak species and tanoak in California and Oregon
- Continues to spread northward in infected areas

BEECH LEAF DISEASE
BEECH
- A newly identified beech disease caused by a nematode
- Reported for the first time in Connecticut

SOUTHERN PINE BEETLE
SOUTHERN PINES
- A major pest of southern yellow pine forests that greatly influences pine ecology and timber production
- Tree mortality declined across the Southeastern United States

SPRUCE BEETLE
SPRUCE
- Attacks most spruce trees across its range
- Caused tree mortality across 133,000 acres in Alaska, which is less than 2018 reports

EMERALD ASH BORER
ASH
- Devastates ash trees in urban and community forests and native hardwood forests
- Continues to spread to additional counties in infested States, but no new States in 2019

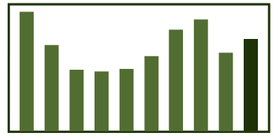
FIR ENGRAVER
WESTERN FIRS
- Significantly impacts fir species on the west coast
- Caused tree mortality across 1.9 million acres in California

SPONGY MOTH
HARDWOODS
- Defoliation can result in reduced annual growth, canopy dieback, and death
- Caused defoliation across 198,000 acres in Michigan and mortality across 154,000 acres in Connecticut

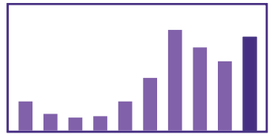
ACTIVITIES SUPPORTED BY FOREST HEALTH PROTECTION

SUDDEN OAK DEATH	SOUTHERN PINE BEETLE	EMERALD ASH BORER	FIR ENGRAVER	SPONGY MOTH	SPRUCE BEETLE	BEECH LEAF DISEASE
Stream detection and treatments in targeted areas	Suppression of active infestations and thinning forest for prevention	Provide technical assistance and outreach	Surveying, suppression, and developing management options	Eradication, suppression, and Slow the Spread Program	Pest suppression, detection, management, and treatments	Causal agent surveys were performed and are ongoing in the East

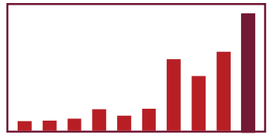
TREE MORTALITY SURVEY TRENDS 2010–2019



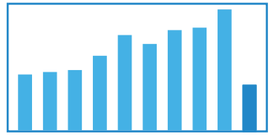
ALL TREE MORTALITY
7.1 MILLION ACRES
IN 2019



FIR ENGRAVER
2.7 MILLION ACRES
IN 2019

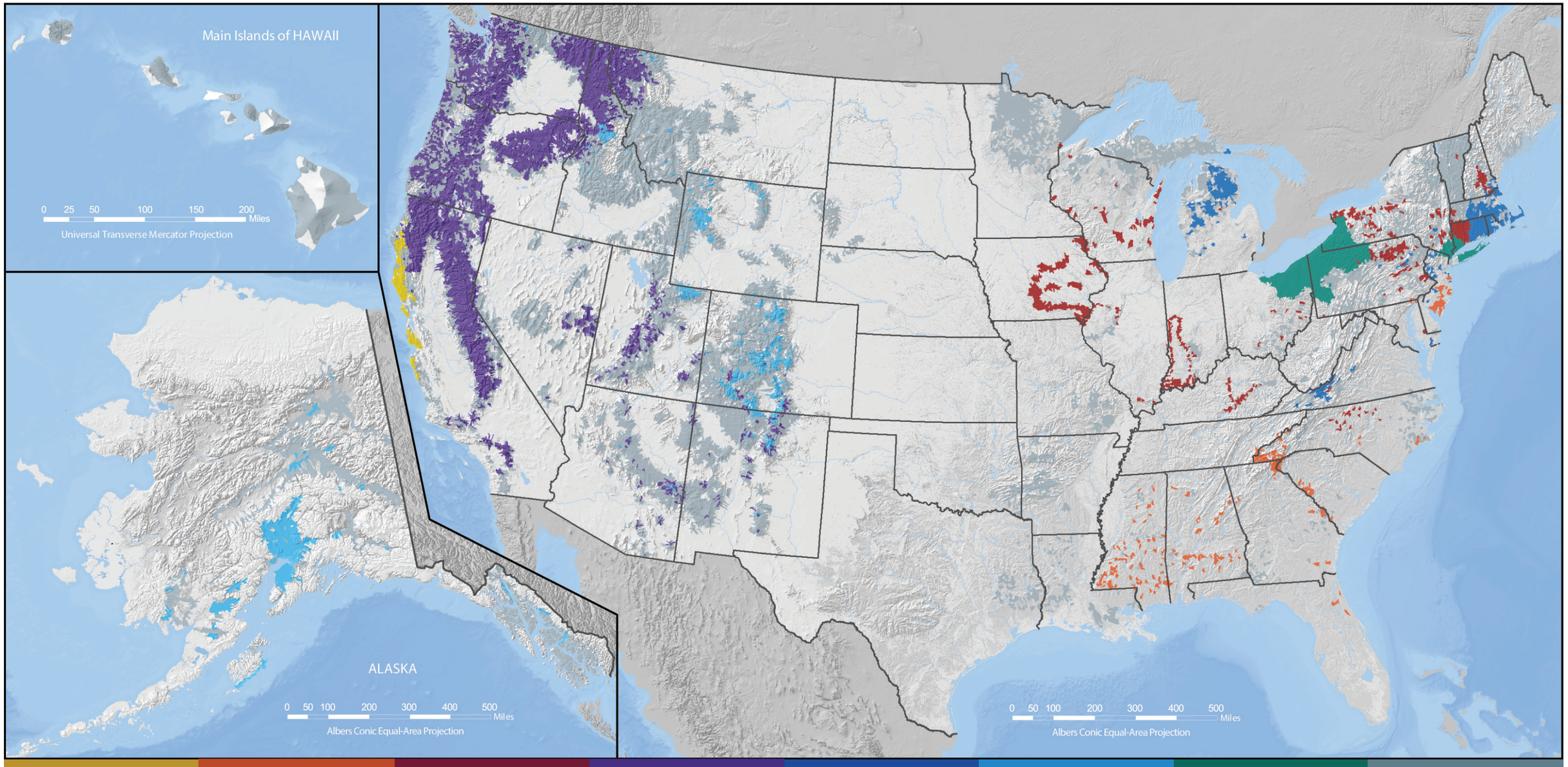


EMERALD ASH BORER
1.3 MILLION ACRES
IN 2019



SPRUCE BEETLE
325,000 ACRES
IN 2019

2019 INSECT AND DISEASE SURVEY—WATERSHEDS WITH TREE DAMAGE



Sudden oak death | Southern pine beetle | Emerald ash borer | Fir engraver | Spongy moth | Spruce beetle | *Beech leaf disease | ** Other damage

*Displayed as watersheds in counties reported to have beech leaf disease. **Includes damage from western spruce budworm, hemlock looper, hemlock sawfly, pinyon ips, mountain pine beetle, and many other less significant pests.

Port-Orford-Cedar Root Disease

Phytophthora lateralis

Loss of large Port-Orford-cedars has negative ecological impacts.

Dead young Port-Orford-cedars turn reddish brown. Photo by Richard Sniezko, USDA Forest Service.

Port-Orford-cedar root disease is caused by the introduced pathogen *Phytophthora lateralis*. It was first discovered within the native range of Port-Orford-cedar in 1952. Port-Orford-cedar root disease causes mortality and predisposes infected hosts to attacks by cedar bark beetles. Extensive mortality occurs along streams, near drainage ditches, and on poorly drained sites. The extensive killing of large Port-Orford-cedar in riparian zones by this disease may have severe ecological consequences.

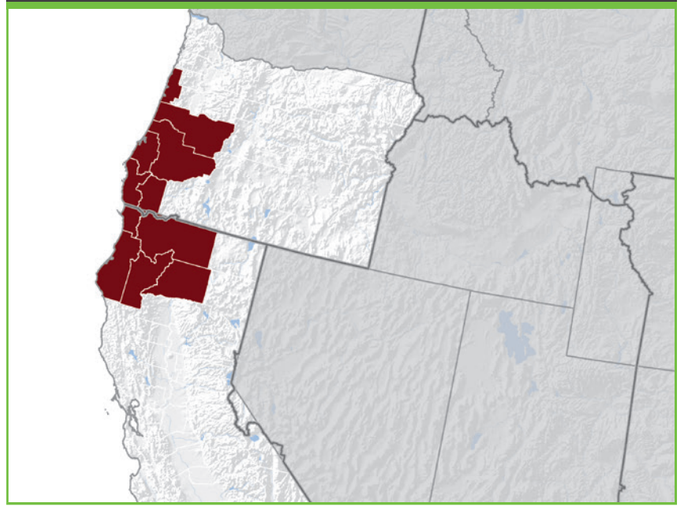
Port-Orford-cedar root disease is present in western Oregon and western Washington. In southwestern coastal Oregon, tree mortality is concentrated in areas of standing or flowing water and on poorly drained microsites. In northern coastal Oregon, Port-Orford-cedar root disease is damaging on Port-Orford-cedar forest plantations outside of the natural range of Port-Orford-cedar. Port-Orford-cedar root disease is also found in urban plantings in western Oregon and southwestern Washington, with arborvitae being a common host.

HOST: **PORT-ORFORD-CEDAR**

- **First discovered** within the native range of Port-Orford-cedar in 1952
- **Extensive mortality occurs** along streams, near drainage ditches, and on poorly drained sites

Port-Orford-cedar root disease caused death of outer branch. Photo by Richard Sniezko, USDA Forest Service.

FOREST DAMAGE AND RANGE



Beech Leaf Disease

Litylenchus crenatae mccannii

Nematode detection helps identify disease.

Dark, thickened stripes between leaf veins are early beech leaf disease symptoms. Photo by Matt Borden, Bartlett Tree Experts.

In 2019, researchers discovered a link between the foliar nematode, *Litylenchus crenatae mccannii*, and beech leaf disease (BLD) symptoms. Detection of the nematode helped identify BLD in New York and Connecticut. Surveys continue to identify BLD in additional counties in New England and mid-Atlantic States including New York, Connecticut, Pennsylvania, and Ohio. Ground surveys are used to detect and delimit areas of infection.

Symptomatic trees were observed in natural forest settings and in urban and community forests.

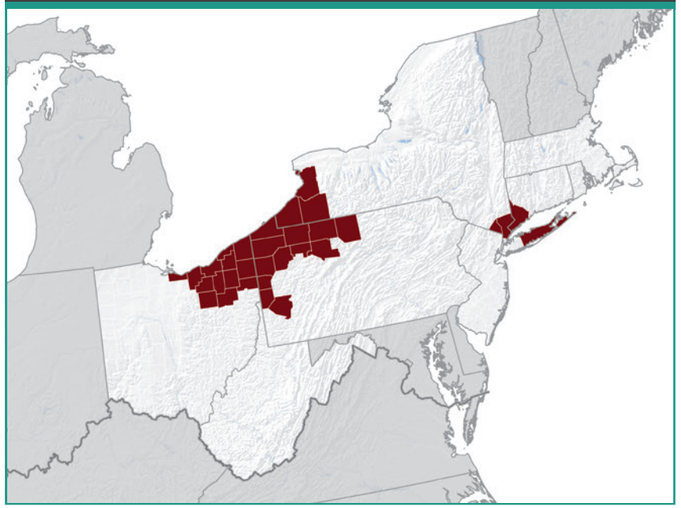
In New York, BLD symptoms were more severe in 2019 than previous years. Work continues to investigate BLD and its potential vectors, impact, and interactions with biotic and abiotic stressors across States known to have BLD including Connecticut, New York, Pennsylvania, Rhode Island, and the Province of Ontario.

HOST: **BEECH**

- A **newly identified** beech disease
- **Reported for the first time** in Connecticut in 2019

Beech leaf disease banding after several years of infection. Photo by Matt Borden, Bartlett Tree Experts.

FOREST DAMAGE AND RANGE



Sudden Oak Death

Phytophthora ramorum

Identified in California, Oregon, and Washington.

Foliar symptoms of sudden oak death on tanoak. Photo by Joseph O'Brien, USDA Forest Service.

Sudden oak death (SOD), caused by *Phytophthora ramorum*, has been identified in Washington, Oregon, and California. Outbreaks of SOD continued to cause mortality in California and Oregon. Aggressive treatment can contain the disease on a site. In Washington, SOD has not been detected in the forest, but was identified by the Washington State Department of Agriculture in an infected Himalayan blackberry during a perimeter search around a nursery with infected material; samples collected from the nearby Chehalis River, however, tested negative for *P. ramorum*.

In Oregon, SOD spread continued throughout the affected area. Ground surveys detected 197 trees positive for SOD; 66 are known European (EU1) lineage and 44 are awaiting lineage identification. Because of the aggressiveness of the EU1 lineage, those infestations are given higher priority for containment treatments. Containment treatments for EU1 infestations totaled 117 acres in 2019. Treatments are underway or planned on the remaining acres of EU1 infestations detected in 2018 and 2019.

High levels of mortality on tanoak and California bay laurel were observed throughout the pathogen's known distribution in California including Sonoma, Monterey, and Humboldt Counties and the San Francisco Bay area in 2019. Estimated tree mortality caused by SOD decreased slightly from 2018 levels in the north and central coasts indicating that 2019 was the second year of an overall SOD expansion following robust winter precipitation in 2016–2017.

Mortality and decline of oaks caused by sudden oak death. Photo by Bruce Moltzan, USDA Forest Service.

New or expanded areas of infection were observed in Santa Clara, Santa Cruz, and Del Norte Counties.

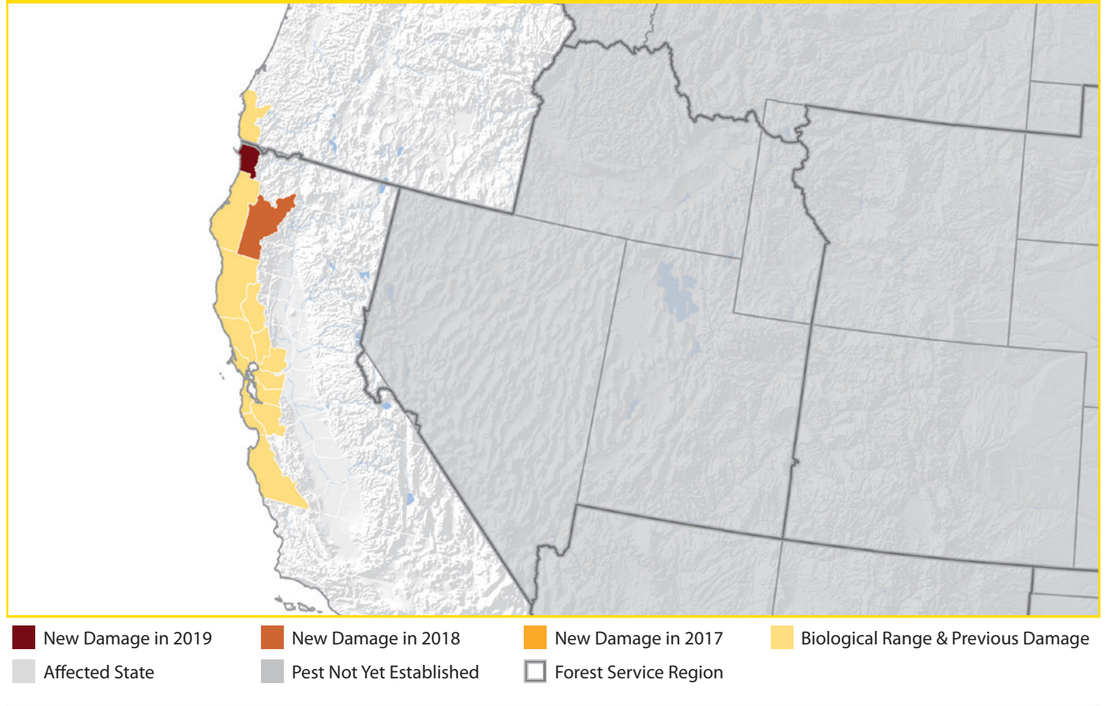
In Humboldt County, the pathogen increased mortality along the Redwood Creek corridor and Mattole River including Tall Trees Grove in Redwood National Park. In Mendocino County, areas of increased mortality were observed in the Inglenook area north of Fort Bragg and east of Boonville in the Con Creek and Indian Creek watersheds. In western Sonoma County, tanoak mortality intensified to 70–90 percent around Fort Ross and Timber Cove. New mortality was observed north of Calistoga. Monterey County also exhibited intensified tanoak mortality in 2019. The Big Creek, Mill Creek, Plaskett Creek, and Willow Creek watersheds showed levels of tree death comparable to those of stages of the outbreak in 2000.

HOST: OAK AND TANOAK

- **Kills several oak species and tanoak** in California and Oregon
- **Continues to spread northward** in infected areas

Zoomed view of *P. ramorum* showing zone lines on coast live oak. Photo by Joseph O'Brien, USDA Forest Service.

FOREST DAMAGE AND RANGE



Southern Pine Beetle

Dendroctonus frontalis

Scattered mortality in overstocked stands.

Pine trees killed by the southern pine beetle. Photo by Ronald F. Billings, Texas A&M Forest Service, Bugwood.org.

In 2019, all States in the Southeast reported a decline in southern pine beetle (SPB) infestations. Only 2 counties in Mississippi were officially in outbreak status in 2019 compared to 19 counties in 2018. These two counties represented areas in and around the National Forests of Mississippi where there was major SPB activity the recent past.

Across the Southern Region, most States observed low levels of SPB activity in 2019. Mississippi, Georgia, Alabama, Florida, and South Carolina reported scattered activity concentrated in overstocked stands. North Carolina and Virginia reported small pockets of mortality caused by SPB on fewer than 20 trees per site. Louisiana detected SPB in traps in two parishes but reported no infestations.

Infestations and trap catches of the SPB were down across the Eastern Region. Most States are participating in annual pheromone-based detection trapping efforts to monitor SPB populations. Massachusetts, Rhode Island, Pennsylvania, Maryland, Delaware, Connecticut, West Virginia, and Ohio did not report any tree damage by the SPB even when beetles were caught in traps.

The southern pine beetle continued to cause pine mortality in New York and New Jersey. New Jersey observed a decrease in impacted acres from 2018. On Long Island, NY, damage was reduced below outbreak levels in part due to the State's sustained suppression efforts. The SPB was most active in the town of East Hampton outside the core of the Central Pine Barrens. The SPB was not detected in traps north of Long Island, despite beetles being detected there in previous years.

Southern pine beetle galleries with blue stain fungi and adult beetles. Photo by Ronald F. Billings, Texas A&M Forest Service, Bugwood.org.

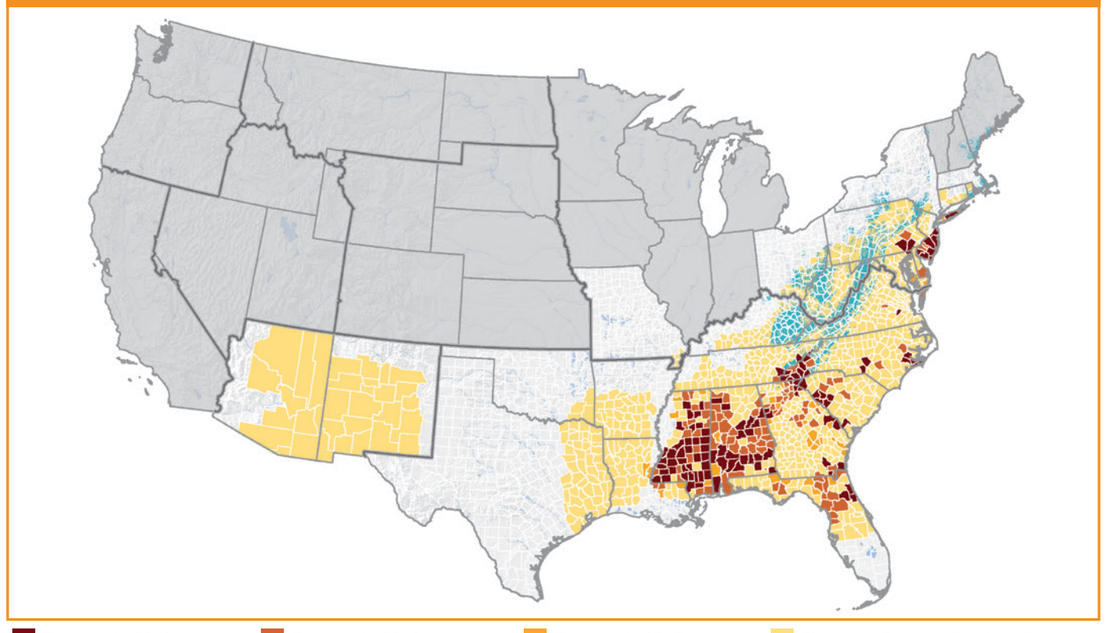
Adult southern pine beetle in flight. Photo illustration by Sheryl A. Romero, USDA Forest Service. Photo by Erich G. Vallery, USDA Forest Service.

HOST: **SOUTHERN PINES**

- A major pest of southern yellow pine forests that **greatly influences pine ecology and timber production**
- Tree mortality associated with the southern pine beetle **declined across the Southeastern United States**

Pitch tubes on shortleaf pine are a sign of southern pine beetle attack. Photo by Erich G. Vallery, USDA Forest Service.

FOREST DAMAGE AND RANGE



Emerald Ash Borer

Agrilus planipennis

An exotic wood boring beetle impacting all species of ash in the United States.

An adult emerald ash borer. Photo illustration by Sheryl A. Romero, USDA Forest Service. Photo by USDA Forest Service.

The emerald ash borer (EAB) is known to occur in 35 States. Although it was not found in any new States in 2019, it continued to expand its range within infested States as numerous additional counties and communities identified infestations. Surveys, trapping, and monitoring and detection programs work to identify and quantify areas impacted by the EAB and track ash tree decline and mortality.

In the Eastern Region, the EAB occurs in all 20 States and the District of Columbia. All counties in Connecticut, Pennsylvania, West Virginia, Ohio, and Indiana are impacted. In the mid-Atlantic States, the EAB is found in nearly every county except for counties along the Atlantic seaboard with very little ash resource. The emerald ash borer is present in New England, and by April quarantines were established as far north as northern Aroostook County in northeastern Maine. In the Central States, Illinois, Iowa, Minnesota, Wisconsin, and Missouri have identified additional infested counties.

States in the Eastern Region reported significant mortality in native and urban forests in Connecticut, Massachusetts, New Hampshire, New York, Vermont, Pennsylvania, New Jersey, and Maryland. Missouri identified an additional 21 infested counties, nearly doubling the number from 2018. Michigan is generally infested excluding the western part of the Upper Peninsula. Wisconsin reported heavy ash mortality particularly in areas where stress on ash was exacerbated by flooding including nearly all mature ash in four southeastern counties.

In the Southern Region, the EAB remains undetected in only two States: Mississippi and Florida. The EAB continued to spread across most infested States with multiple new county records established in Georgia, Kentucky, North Carolina, South Carolina, Texas, and Virginia. No new infestations were found in Alabama, Arkansas, Louisiana, or Tennessee.

Southeastern States report various intensities of EAB spread and impact. Virginia has observed aggressive spread with only the southeast portion of the State remaining unconfirmed. Kentucky observed slow westward spread but anticipates the EAB will be confirmed in the remaining western counties in the coming years. Texas observed a significant westward jump to Fort Worth. North Carolina has a scattered distribution of impacted counties. Ash mortality in Arkansas is easily observed along waterways where ash is common.

In the western regions the EAB occurs only in Colorado, Kansas, Nebraska, and South Dakota. Many of the initial western finds are a considerable distance from other known infestations. The Sioux Falls, SD, detection in 2018 was 100 miles from the closest confirmed infestations in Iowa and Minnesota. Likewise, the Boulder, CO, detection in 2013 was over 600 miles from a known infestation. These introductions are most likely the result of the movement of infested materials followed by natural and human-assisted spread. Colorado identified three additional county infestations in 2019 and later dropped all county level quarantines for the the EAB.

A significant threat to ash resource in native and urban forests.

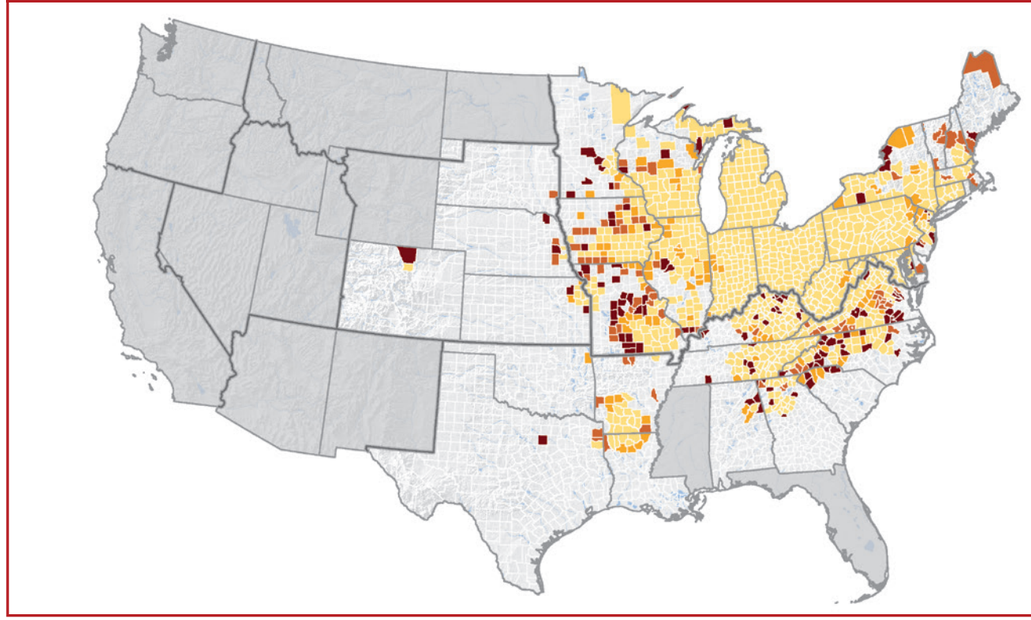
While Western States impacted by EAB infestations remain few, those infestations represent a significant impact on the ash component of those forests. Dendrochronology studies conducted in Colorado and South Dakota suggest that EAB infestations are several years old prior to first detection. Additionally, ash typically represents a significant portion of urban forests in western communities where conditions in urban landscapes are harsh and tree choices are limited.

HOST: **ASH**

- **Devastates ash trees** in urban and community forests and native hardwood forests
- **Continues to spread** to additional counties in infested States, but no new States in 2019

Tree mortality and decline caused by the emerald ash borer. Photo by Christopher Asaro, Virginia Department of Forestry, Bugwood.org.

FOREST DAMAGE AND RANGE



Fir Engraver

Scolytus ventralis

Tree mortality increases during periods of environmental stress.

Mortality and discoloration of white fir caused by the fir engraver. Photo by William M. Ciesla, Forest Health Management International, Bugwood.org.

Fir mortality increased in areas with significant drought stress and in areas experiencing impacts from defoliation. Fir mortality was considerable within the host types in Oregon, Washington, California, Montana, Idaho, Utah, Nevada, Colorado, New Mexico, and Arizona.

Acres with mortality attributed to the fir engraver increased substantially in Oregon and Washington from 2018 to 2019. Widespread damage was mapped in northeastern Washington and throughout the Blue Mountains of eastern Oregon. This beetle is active in overstocked stands of fir on drought prone sites, causing top-kill and tree mortality. The increased mortality is attributed to the recent drought conditions and the effects of western spruce budworm outbreaks in the central Cascades.

Fir mortality in California comprised over 82 percent of the total tree mortality recorded in 2019. In 2018, hot and dry weather conditions in Siskiyou County led to increased mortality caused by the fir engraver beetle. The highest levels of red fir mortality were found on the Plumas National Forest near Pilot Peak. Mortality has also increased at high elevations in the southern Sierras.Elevated levels of white fir mortality continued this year on the San Bernardino National Forest near Barton Flats, Jenks Lake, and the Santa Ana River.

Across the Northern Rocky Mountains, tree mortality from the fir engraver continued to increase in drought impacted areas. Northern Idaho and western Montana experienced widespread mortality of fir. In Nevada and Utah, fir mortality was highly localized. In Nevada nearly 70 percent of this mortality occurred in White Pine County. In Utah over 70 percent of fir mortality was mapped in south-central Utah in the white fir type.

Fir engraver beetle galleries established by feeding larvae. Photo by Scott Tunnock, USDA Forest Service.

Acres affected by fir the engraver on white fir continued to decrease in southern Colorado in 2019. Outbreaks of the fir engraver beetle are often associated with localized drought conditions and occur in areas where white fir has matured on sites more favorable to ponderosa pine. Heavy defoliation by the western spruce budworm has increased tree susceptibility to the fir engraver in Colorado.

Mortality of white fir increased in 2019 in the Southwestern Region.

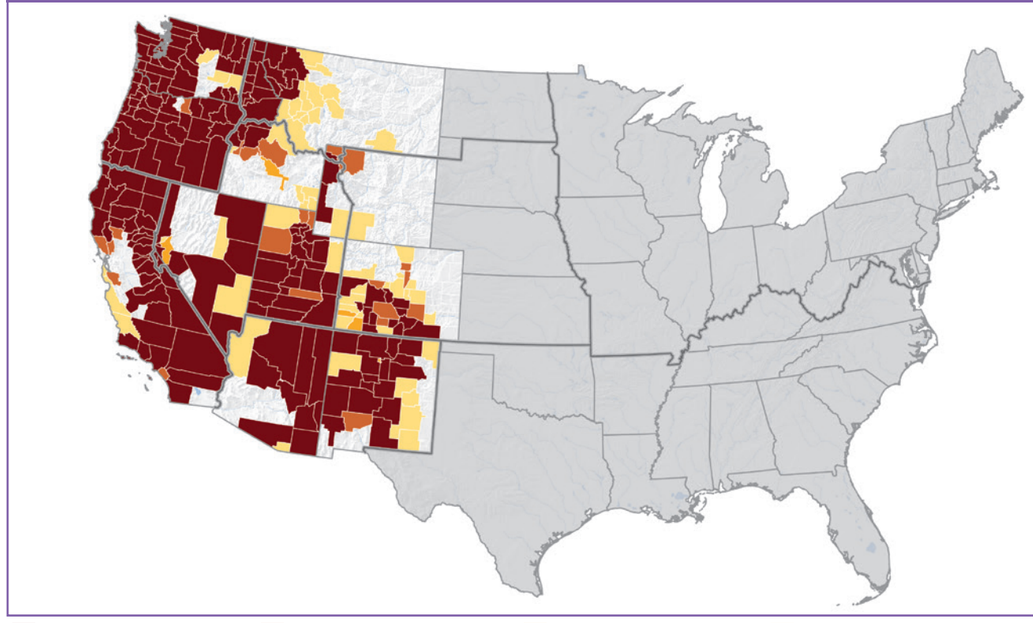
Much of the mortality was documented in areas that suffered extreme and exceptional drought during the winter of 2017–2018. Most of the activity was on the Chuska Mountains of the Navajo Nation that crosses into both Arizona and New Mexico and on Apache Tribal lands in the central part of Arizona. Fir engraver activity on the Sandia Mountains of the Cibola National Forest increased slightly following an outbreak of the Douglas-fir tussock moth in the area.

HOST: **WESTERN FIRS**

- **Significantly impacts** fir species on the west coast
- **Caused tree mortality** across 1.9 million acres in California

Adult fir engraver beetle. Photo by Dan West, Colorado State Forest Service.

FOREST DAMAGE AND RANGE



Spongy Moth

Lymantria dispar dispar

Caterpillar mortality from fungus reduces impact.

Spongy moth larva. Photo by Karla Salp, Washington State Department of Agriculture, Bugwood.org.

Defoliation caused by the spongy moth continued to decrease nationally in 2019. There were 230,190 acres of defoliation in 2019, down from 385,165 acres in 2018 and significantly reduced from the more than 2 million acres reported in 2017. Most of the defoliation occurred in Michigan (195,000 acres), which saw a significant increase from 6,000 acres reported in 2018. Conversely, southern New England, which reported more than 1 million acres in 2017, continued to see a precipitous decrease in defoliation with reports of less than 25,000 acres defoliated. Wet spring conditions throughout many States including Maryland, Massachusetts, Rhode Island, Indiana, and southern Michigan, were beneficial to the fungus *Entomophaga maimaiga* that infects and kills spongy moth caterpillars.

In New England, defoliation varied with States reporting limited impact to individual trees, scattered pockets of defoliation, and tree mortality. In Maine, egg mass and larvae surveys indicated poor caterpillar survival resulting in light defoliation limited to just a few trees. In May 2019, the spongy moth quarantine area was redefined to encompass the entire State of Maine.

New Hampshire, Vermont, Rhode Island, New York, and New Jersey reported some defoliation from the spongy moth in limited areas. Massachusetts recorded pocketed areas of heavy defoliation across the eastern two-thirds of the State. Connecticut reported some defoliation in 2019 but observed considerable tree mortality due to combined effects of defoliation and drought from 2016 to 2018.

The mid-Atlantic States reported very little defoliation, fewer than 2,000 acres, caused by the spongy moth. That activity was reported predominately from Pennsylvania with 869 acres reported and from Maryland with 679 acres of defoliation reported. West Virginia reported 101 acres and no defoliation was observed in Delaware or Ohio.

Michigan reported the most acres of defoliation caused by the spongy moth in 2019 (195,795 acres). Moth populations collapsed in the southern Lower Peninsula of Michigan in 2019 after a wet spring. However, in the northeastern Lower Peninsula, populations appear to be building again. The spongy moth is established in most of Wisconsin, but populations remained low in 2019 and no damage was recorded outside of a few yard trees. Other Central States including Indiana, Iowa, Illinois, Minnesota, and Missouri had no reports of defoliation.

In the South, only Virginia reported defoliation by the spongy moth in 2019 on 8,825 acres. Two new counties, Washington and Smyth, reported defoliation in 2019 marking the spread of the spongy moth into southwest Virginia. Although adult spongy moths are trapped annually in North Carolina, Tennessee, and Kentucky, defoliation has not been reported.

Across the West trapping for adult male spongy moths continues to be a coordinated effort with the Forest Service, USDA's Animal and Plant Health Inspection Service (APHIS), and State agencies.

Annual monitoring and detection traps were negative in Western States with five exceptions—North Dakota, Montana, Oregon, Washington, and California.

The Washington State catch represented a first U.S. record of* Lymantria umbrosa, *a species of Asian origin.

Where adult moths were captured, APHIS protocols will be followed to complete delimitation surveys to assess the extent of infestation. Washington and Oregon conducted eradication treatments in 2019. Oregon will conduct additional eradication actions in Snohomish County in 2020. California will conduct delimitation trapping in 2020 around the Yuma County trap detection.

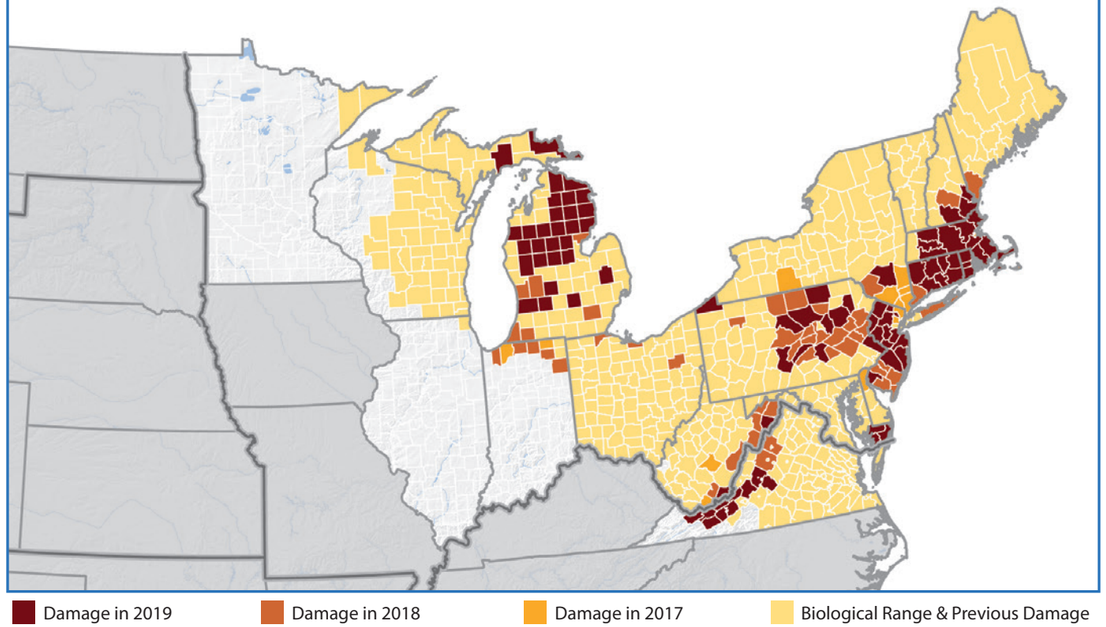
North Dakota conducted year-one of delimitation surveys for 2018 captures. These resulted in no adult moths detected. However, new positive male moth captures were reported in 2019 in Cass and Burleigh Counties. Montana and California made isolated captures of a male spongy moth. Delimitation surveys will occur at all 2019 positive detections in these States.

HOST: **HARDWOODS**

- Spongy moth defoliation **can result in reduced annual growth, canopy dieback, and death**
- **Caused defoliation** across 198,000 acres in Michigan and mortality across 154,000 acres in Connecticut

Regrowth of foliage after spongy moth damage on mixed hardwoods. Photo by Karla Salp, Washington State Department of Agriculture, Bugwood.org.

FOREST DAMAGE AND RANGE



Spruce Beetle

Dendroctonus rufipennis

The dominant mortality agent for mature spruce.

Cumulative tree mortality caused by the spruce beetle on the La Garita Range, CO. Photo by William M. Cielsa, Forest Health Management International, Budwood.org.

The spruce beetle is the primary agent of spruce mortality across North America. Tree mortality from the spruce beetle is reported throughout the West. Some impacted areas are facing host depletion or exhaustion after multiple years of mortality. Other areas observed endemic levels of activity across the forest type.

Spruce mortality in Alaska was about one-third of the acres reported in 2018 with the spruce beetle observed on 133,190 acres statewide. Southcentral Alaska is experiencing the fourth year of a spruce beetle outbreak. White spruce host material is near exhaustion in some areas and an increase in spruce beetle activity in black spruce has been observed. In the urban and community forests of southcentral Alaska, the spruce beetle continues to be the most frequently observed pest in ornamental and landscape trees.

In Washington, the spruce beetle remained at endemic levels. Northwest Okanogan County along the Cascade crest near the Canadian border has a small area with ongoing spruce beetle activity. Surveys detected a new area with mortality caused by the spruce beetle on Blewett Pass near the Chelan-Kittitas County line.

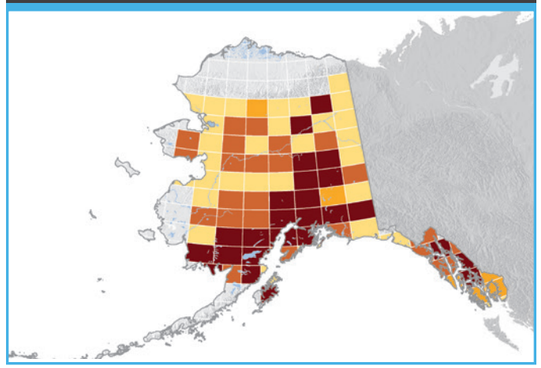
In the Northern Rocky Mountains, mortality caused by the spruce beetle remained at low levels. Beetle populations remained endemic throughout the majority of northern Idaho and Montana. An outbreak that erupted in 2017 continued in 2018–2019 on the Nez Perce-Clearwater National Forests in northern Idaho.

In the Intermountain Region, the spruce beetle remained active with approximately 55,000 acres impacted, mostly in Utah. The Uinta-Wasatch-Cache and Ashley National Forests continued to have significant outbreaks. Tree mortality on the Bridger-Teton National Forest in western Wyoming continued with over 18,000 acres infested in 2019.

In Colorado, tree mortality from the spruce beetle occurs predominately in and adjacent to Rocky Mountain National Park and in and around the Buffalo Peaks Wilderness, the Collegiate Peaks, the Uncompahgre Wilderness, and portions of the Weminuche Wilderness in southern Colorado. In Wyoming, surveys detected spruce beetle activity on more than 4,000 acres in areas south of Togwotee Pass.

In Arizona, individual spruce tree mortality has been mapped over the past few years, and in 2019 small patches with light levels of spruce mortality were seen on Mount Baldy. In New Mexico, spruce beetle activity continued to kill Engelmann spruce in spruce-fir forests in the northern part of the State, primarily on the Carson and Santa Fe National Forests. Some stands have experienced several years of bark beetle activity and have recorded greater than 90 percent spruce mortality. A small amount of spruce beetle activity continued on Sierra Blanca peak in the Sacramento Mountains in the southern part of the State. The spruce beetle was also observed on the Ski Apache ski area and nearby Mescalero Apache Tribal lands.

FOREST DAMAGE AND RANGE

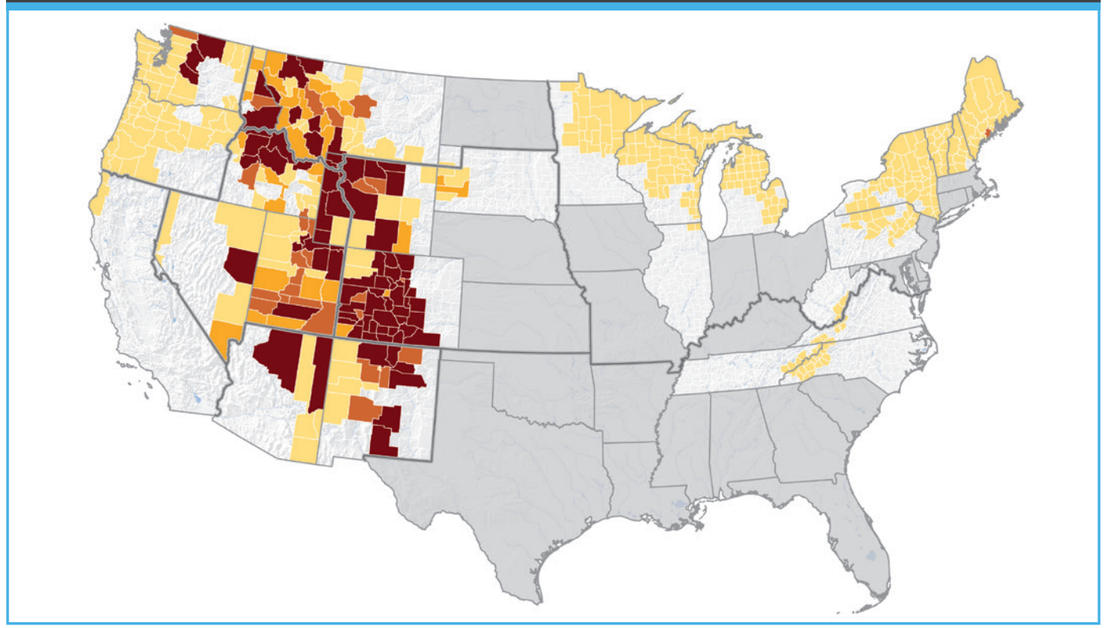


HOST: **SPRUCE**

- **Attacks most spruce trees** across its range
- **Caused tree mortality** across 133,000 acres in Alaska, which is less than 2018 reports

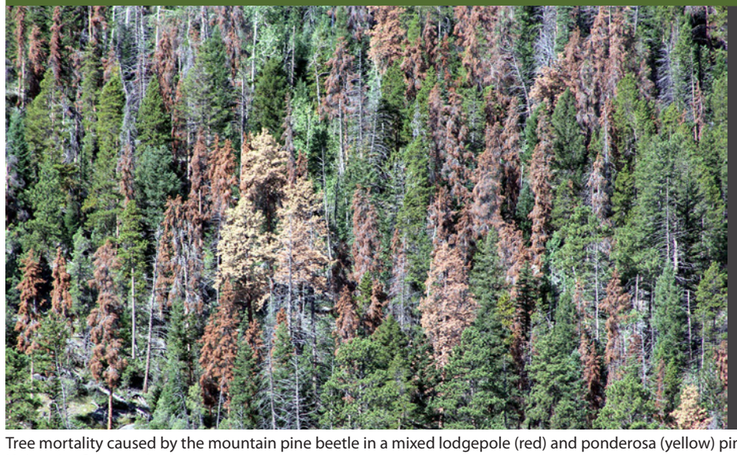
Spruce beetle adult. Photo by William M. Cielsa, Forest Health Management International, Budwood.org.

FOREST DAMAGE AND RANGE



Mountain Pine Beetle

Dendroctonus ponderosae



Reduced impact as outbreak subsides across the interior West.

Tree mortality caused by the mountain pine beetle in a mixed lodgepole (red) and ponderosa (yellow) pines. Photo by Whitney Cranshaw, Colorado State University, Bugwood.org.

Acres infested with the mountain pine beetle (MPB) continued to decline in 2019. Across the West, 301,000 acres were reported to have trees killed by the mountain pine beetle, down from 307,000 in 2018 and more than 1.5 million in 2016. Most Forest Service regions saw a decrease in acres impacted by the MPB, although some areas saw localized increases.

The Pacific Northwest saw an overall decrease in acres with mortality attributed to the MPB, although local outbreaks continue to be active. In Washington, pine mortality remained endemic with increased activity in lodgepole pine and decreased activity in other hosts. Tree mortality was elevated within the Okanogan-Wenatchee National Forest and the Yakama Indian Reservation. In Oregon, the MPB mostly impacts dense stands of lodgepole. The mountain pine beetle may be found in combination with the western pine beetle in larger diameter ponderosa pine. Damage from both beetles was most concentrated in the Fremont-Winema, Malheur, and Wallowa-Whitman National Forests.

Mortality caused by the mountain pine beetle was common throughout California and increased over 2018 levels. Tree mortality from the MPB was heaviest in the southern and eastern Sierra Nevada and on the north flank of Mt. Shasta. Large increases in tree mortality were seen by aerial survey in whitebark pine and western white pine. Mortality of sugar pine and limber pine was attributed to the MPB by aerial survey. Moderate to severe western white pine mortality was observed on Bald Mountain on the Modoc National Forest and Babbitt Peak on the Tahoe and Humboldt-Toiyabe National Forests.

In the Northern Rocky Mountains, MPB activity increased in area, but decreased in severity over those acres. Lodgepole pine remains the predominant host species and accounts for 95 percent of the mortality caused by the MPB. In northern Idaho, mortality increased slightly in Idaho and Shoshone Counties. In Montana, more than twice the acres were affected than in 2018. Most of the activity in Montana occurred in Lincoln and Sanders Counties.

Mountain pine beetle larval galleries. Photo by Scott Tunnock, USDA Forest Service.

Across the Intermountain Region, mortality caused by the MPB is at endemic levels. Most of the pine tree mortality occurred on the Humboldt-Toiyabe National Forest in limber and whitebark pines. Drought coupled with warmer temperatures and landscapes composed of susceptible hosts are significant factors contributing to tree mortality. Areas with scattered mortality in lodgepole pine include the Payette National Forest and the Uinta-Wasatch-Cache National Forest.

In the Central Rocky Mountains, the MPB remains at endemic levels across most of the area.

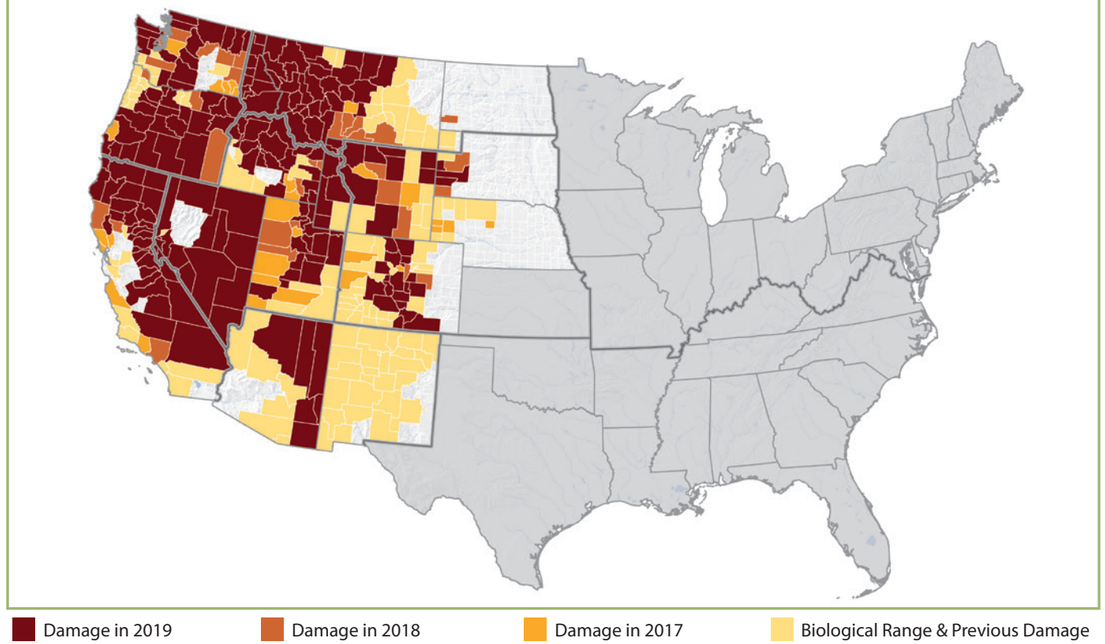
A new outbreak was detected on the Gunnison Ranger District on about 600 acres. Ground surveys show an increasing population in Taylor Canyon with abundant larger diameter lodgepole pines that could support a growing outbreak. On the Coronado National Forest in Arizona low populations of the MPB continue to be observed on southwestern white pine. Ground surveys indicate that while most of the dead trees had some MPB, the mortality seemed to be driven by *Ips bonanseai*.

HOST: **WESTERN PINES**

- **Tree mortality from mountain pine beetle increased** in California
- **Drought and warming temperatures increases** host susceptibility

Mountain pine beetle adult. Photo by Whitney Cranshaw, Colorado State University, Bugwood.org.

FOREST DAMAGE AND RANGE



White Pine Blister Rust

Cronartium ribicola

Resistance gene identified in limber pine.

White pine blister rust sporulating on western white pine. Photo by Chris Schnepf, University of Idaho, Bugwood.org.

White pine blister rust (WPBR), caused by Cronartium ribicola, has spread throughout the range of five-needled pines since its introduction to Western North America in the early 1900s. Stands with WPBR are characterized with a hazard rating based on the severity of infection and the number of infected trees, which is used to inform management. It causes branch flagging, top-kill, and mortality of five-needled white pines. By rapidly killing young trees and cone-bearing branches in mature trees, this disease has had severe impacts on regeneration, making reestablishment of natural populations of five-needled pine species on high hazard sites difficult or impossible. White pine blister rust can also significantly weaken large, older trees making them vulnerable to bark beetle attack. The disease has substantially decreased host populations and has altered stand structure, composition, and function on sites where five-needled pines have major ecological roles.

White pine blister rust is found throughout the historic range of western white pine in western Washington and Oregon. High elevation whitebark pine forests are also affected. Sugar pine is impacted in southwest Oregon. White pine blister rust is found on all host types in Montana, Idaho, Wyoming, and Nevada. In the Intermountain Region, WPBR is most frequently found on whitebark and limber pines.

Infected western white pine and sugar pine are found only on the Humboldt-Toiyabe National Forest along the California/Nevada border.

In the Northern Region, western white pine, whitebark pine, and limber pine are hosts of WPBR. High incidences of disease occur on all three hosts. White pine blister rust has spread throughout the range of western white pine in the inland Northwest and throughout the range of limber pine in Montana. Effects of WPBR on regeneration in whitebark pine in a study of four northern Idaho sites showed severe losses of whitebark pine, with highest infection levels and mortality in new regeneration.

Several Western States have supported efforts to identify resistance in whitebark and limber pines. Presence of resistance in natural populations of five-needled pines will affect outcomes of WPBR epidemics in pine hosts. A major gene for resistance in limber pine has been identified. Frequency of resistance across populations of limber pine recently exposed to WPBR ranges from 5 to 14 percent.

Branch flagging, a symptom of white pine blister rust infection, occurs after the canker has girdled the branch. Photo by John W. Schwandt, USDA Forest Service.

Southwestern white pine is the primary host of WPBR in New Mexico and Arizona. The infestation in the Sacramento and White Mountains of southern New Mexico is advanced and causing widespread crown dieback and mortality in high and moderate hazard sites. The disease is still colonizing new areas within New Mexico. In the spring of 2019, a single infection was found in the Magdalena Mountains of Cibola National Forest.

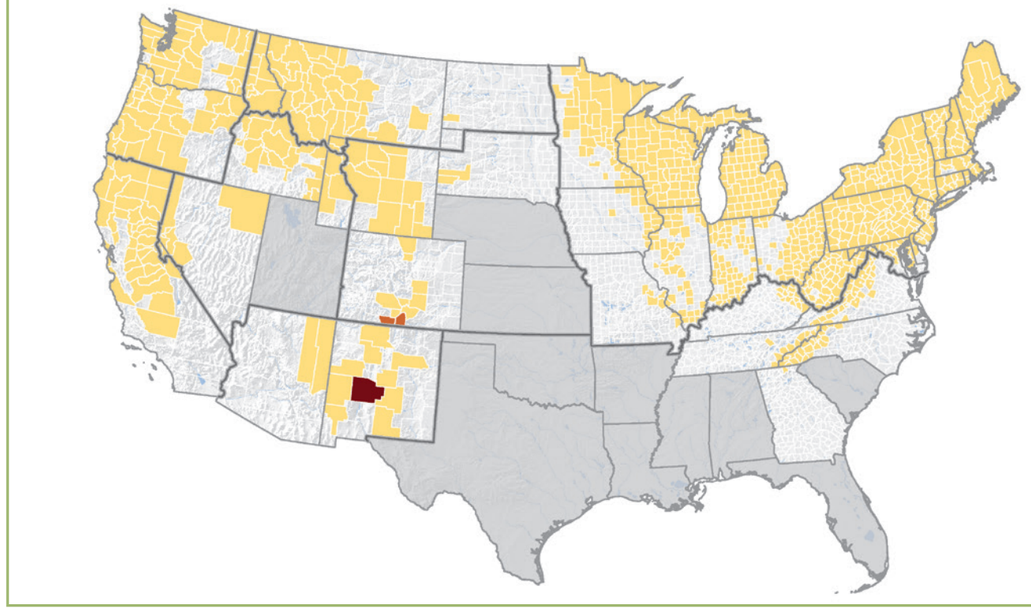
In the Eastern Region, Maine and Vermont reported morality caused by WPBR. White pine blister rust can be found throughout Maine. It remains a significant threat, especially to white pine regeneration and sapling-sized trees and stands. Damage from WPBR was observed occasionally statewide in Vermont with mortality mapped in eight counties.

HOST: **WHITE PINES**

- ★ An exotic rust disease **impacting all North American white pines**
- ★ **Impacts mature trees** and **reduces regeneration** success

Stem cankers caused by white pine blister rust eventually girdle and kill trees. Photo by Susan K. Hagle, USDA Forest Service.

FOREST DAMAGE AND RANGE



Dutch Elm Disease

Ophiostoma ulmi

Tree losses mitigated through strict management.

Wilting leaves are a common symptom of Dutch elm disease. Photo by Minnesota Department of Natural Resources, Bugwood.org.

Dutch elm disease (DED) continues to spread and intensify throughout urban areas of North Dakota, Montana, and Idaho. Dutch elm disease impacts both native and nonnative elms and has altered riparian forests, decimated windbreaks, and eliminated many boulevard trees in communities. Strict management and control ordinances in larger communities have reduced the amount of mortality and the need for tree removal. However, smaller communities often do not have resources available to successfully manage DED, and they continue to lose elms.

In North Dakota, DED continues to be the most prominent disease of community forests. The disease has eliminated most native elms in the eastern half of the State. In western parts of the State where the disease is not managed it is causing considerable mortality in wooded draws and riparian areas. There were no new reports of DED outbreaks in Idaho in 2019, but there are few remaining American elms in northern Idaho communities.

HOST: **ELM**

- DED infected tree **has immediate symptoms** that include wilting and sudden leaf colors change
- Long-term DED management **is successful** in preserving American elms

Zoomed view of Dutch elm disease reproductive structures called synnemata. Photo by Sandra Jensen, Cornell University, Bugwood.org.

Elm tree exhibiting signs of Dutch elm disease. Photo by USDA Forest Service.

Rapid ʻŌhiʻa Death

Ceratocystis huliohia and *Ceratocystis lukuohia*

Rapid response plans reduce spread of ROD.

ʻŌhiʻa forest showing dieback resulting from rapid ʻōhiʻa death. Photo by Paul Berkowitz, Pacific Island Ecosystems Research Center.

ʻŌhiʻa is the most common tree species in Hawaii's native forests. ʻŌhiʻa trees account for 50 percent of all forest trees in the State. This abundant tree provides habitat to native flora and fauna. It is also a culturally significant tree species. Rapid ʻōhiʻa death (ROD) is a disease caused by the *Ceratocystis* fungi. In 2018 research identified two distinct but related species of *Ceratocystis* fungi: *Ceratocystis huliohia*, a slow spreading canker disease, and *Ceratocystis lukuohia*, an aggressive wilt disease. ROD has killed over 1 million ʻōhiʻa tress on 180,000 acres of land and has spread to all major islands in Hawaii. Effort continues to improve understanding and develop management practices for ROD in Hawaii. Semiannual aerial surveys of the State's ʻōhiʻa forests were used to identify new disease outbreaks. ROD is widespread in areas of forest containing ʻōhiʻa on the island of Hawaii. Spot infections are found on the islands of Oahu, Maui, and Kauai.

The aggressive *Ceratocystis lukuohia* has caused most of the mortality seen on Hawaiʻi Island. On Kauaʻi both *Ceratocystis* species have been detected, however, ROD infections are limited to fragmented, invaded forests in lowland areas. Managers in Kauaʻi are working to prevent spread into the island's core ʻōhiʻa forests. Detections of *C. huliohia* on Maui and Oʻahu were quickly responded to by crews guided by recently developed rapid response plans to reduce spread of ROD.

HOST: **ʻŌHIʻA**

- ʻŌhiʻa trees **account for 50 percent of all forest trees** in Hawaiʻi
- The aggressive *Ceratocystis lukuohia* **has caused most of the mortality** seen on Hawaiʻi Island
- Managers in Kauaʻi **are working to prevent spread** into the island's core ʻōhiʻa forests

FOREST DAMAGE AND RANGE