



United States Department of Agriculture

Major Forest Insect and Disease Conditions in the United States: 2015



Forest Service

FS-1093

July 2017

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Major Forest Insect and Disease Conditions in the United States: 2015

COMPILED BY TARA HAAN KAREL AND GARY MAN
FOREST HEALTH PROTECTION

Cover photo: *Western spruce budworm defoliation of grand fir trees near Blewett Pass, Kittitas County, WA, in the Okanogan-Wenatchee National Forest, August 2010. Photo by Garrett Meigs, Oregon State University postdoctoral research associate.*



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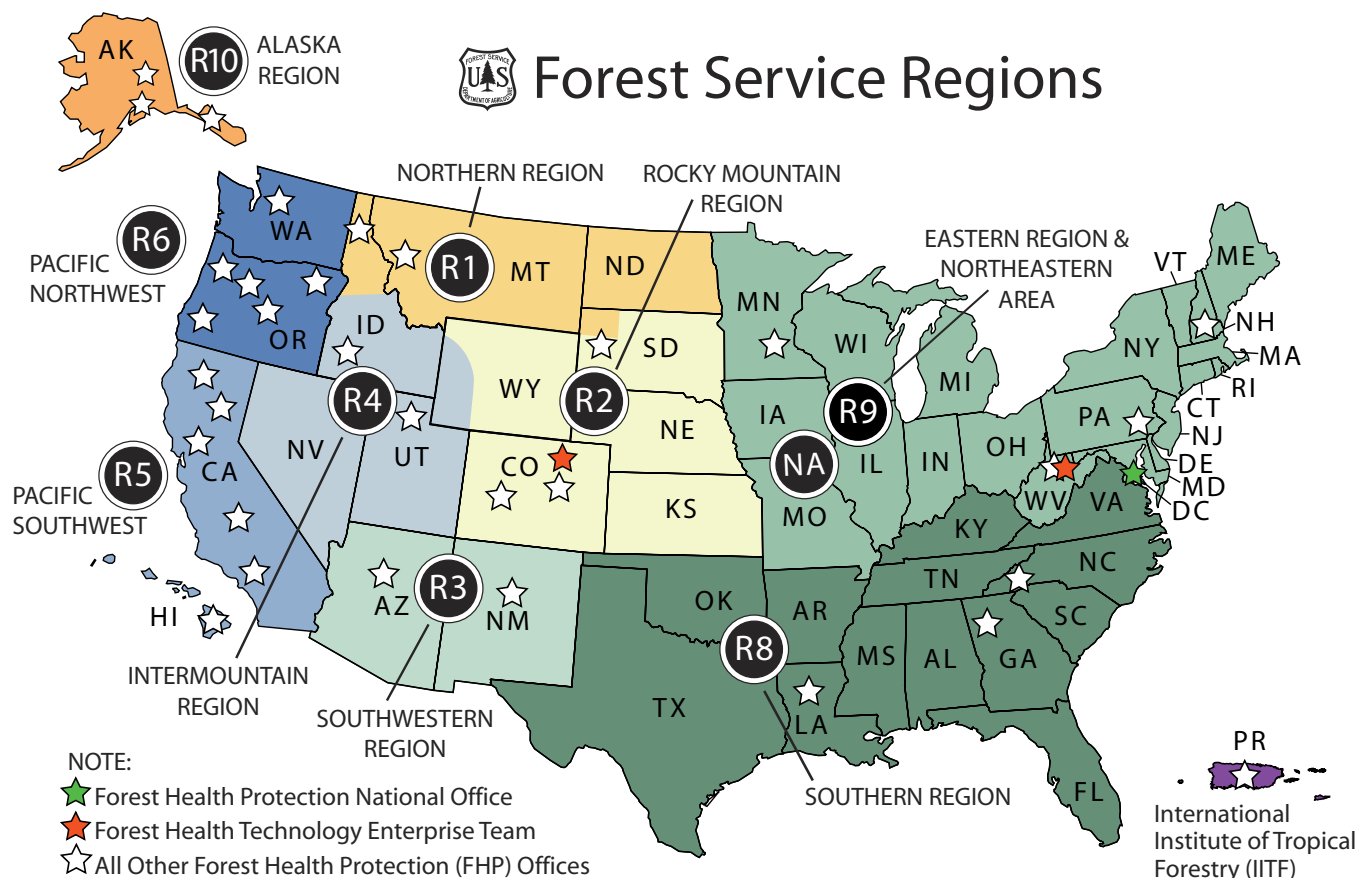
Preface

This report on the major insect and disease conditions of the Nation's forests represents the 65th annual report prepared by the U.S. Department of Agriculture, Forest Service. The report focuses on 19 major insects and diseases that annually cause defoliation and mortality in U.S. forests. The 2007 report, *Major Forest Insect and Disease Conditions in the United States 2007* (<http://www.fs.fed.us/foresthealth/publications.shtml#reports>) provides background on the insects and diseases described in this report. Refer to the 2007 report for more detailed information. This 2015 update provides a national summary of the major changes and status of 19 forest pests with updated charts, tables, and maps. Additional information on these and other pests is available at <http://www.foresthealth.fs.usda.gov/portal>.

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 detecting and reporting insect and disease epidemics. State and Forest Service program specialists regularly conduct detection and monitoring surveys.

For additional information about conditions, contact a Forest Service office listed on the next page (see map for office coverage) or your State forester.

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Content

| | |
|--|----|
| Executive Summary/Introduction | 1 |
| Mountain Pine Beetle..... | 3 |
| Gypsy Moth..... | 7 |
| Southern Pine Beetle | 9 |
| Emerald Ash Borer..... | 12 |
| Sudden Oak Death | 15 |
| Spruce Beetle | 17 |
| Western Bark Beetles | 19 |
| Western Spruce Budworm | 24 |
| Hemlock Woolly Adelgid..... | 27 |
| Laurel Wilt Disease/Redbay Ambrosia Beetle | 29 |
| Spruce Budworm | 30 |
| Sirex Woodwasp..... | 32 |
| Asian Longhorned Beetle | 33 |
| White Pine Blister Rust..... | 34 |
| Oak Wilt..... | 36 |
| Dogwood Anthracnose..... | 37 |
| Beech Bark Disease | 38 |
| Pests To Watch | 40 |
| Root Diseases | 40 |
| Rapid Ōhi'a Death..... | 45 |

Executive Summary/Introduction

Insects and diseases play critical roles in maintaining healthy, resilient ecosystems, but they are also among the most serious environmental and economic threats to the millions of acres of forests and urban treed areas in America. Natural and anthropogenic stressors will continue to influence the establishment, spread, and impacts of insects and diseases on forests. Tree species may be positively or negatively impacted by these changes, altering the array of products and services derived from forested lands, including timber, recreation, 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 so that Federal and State agencies and other stakeholders can prioritize future actions and ensure forests remain resilient and sustainable into the future. The overall mortality caused by insects and diseases varies by year and by pest. Figure 1 illustrates these variations over the past 18 years.

Acres of Tree Mortality Caused by Insects and Diseases

More than 6 million acres of mortality caused by insects and diseases nationally were reported in 2015, 1.3 times greater

than the previous year, when mortality were reported on 4.6 million acres. Total mortality in 2015 was the highest reported since 2011, when 6.6 million acres of mortality was reported. The mountain pine beetle, a native insect found in forests of the Western United States, caused nearly 22 percent of total mortality in 2015.

In addition to mortality, defoliating pests, which damage trees by eating leaves or needles and can cause significant losses of foliage, also substantially alter forests. The western spruce budworm caused more than 3.1 million acres of defoliation damage in 2015, an increase of more than 1 million acres from 2014. European gypsy moth defoliation was reported on more than 1.5 million acres in 2015, nearly 3.9 times greater than in 2014, when defoliation was reported on about 393,000 acres. A single defoliation event does not usually cause tree mortality; however, taken together with continued attacks or severe abiotic factors, such as weather and drought, trees can succumb to these defoliating insects.

Use caution when interpreting the maps in this document because data are displayed at the county scale. If damage was reported at just one location in the county, the whole county is displayed as affected. This protocol is used because data for some pests are collected only at the county level. In addition,

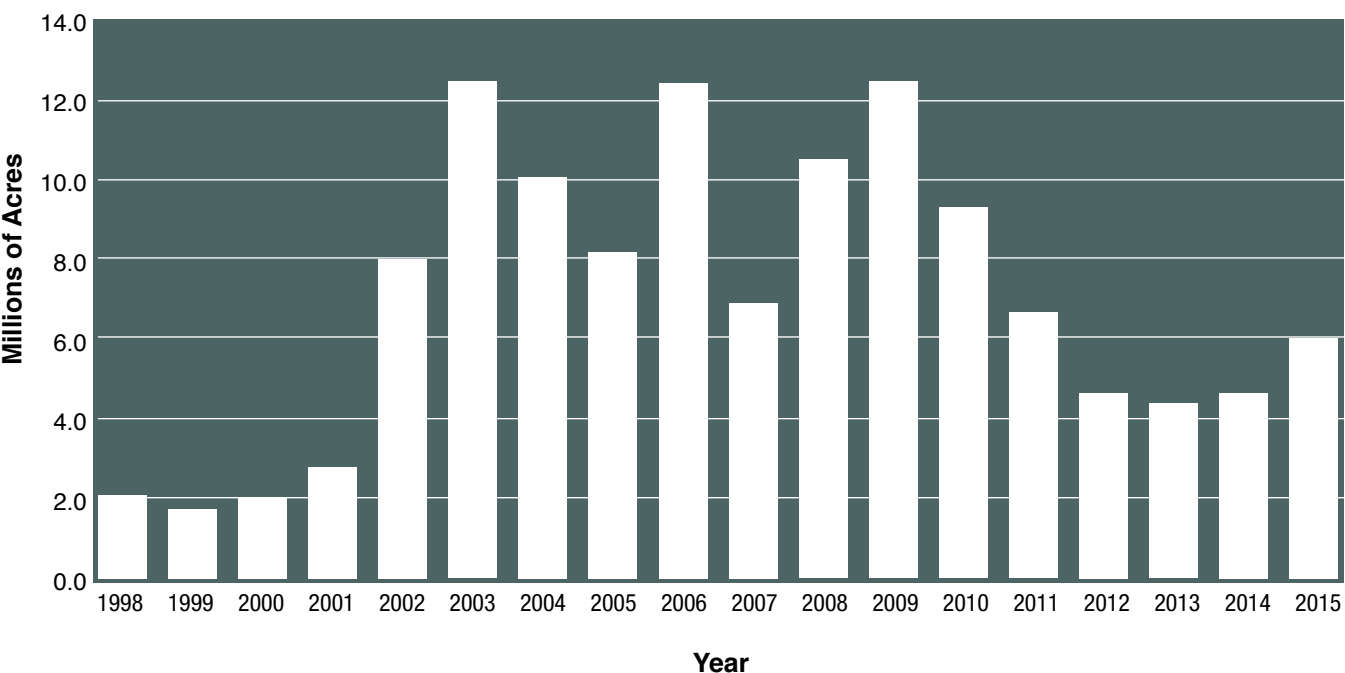


Figure 1. Surveyed acres with mortality from 1998 to 2015.

if the damage were reported at a finer pixel size, many areas would not be visible at the scale used in this publication. For example, numerous counties reported southern pine beetle mortality in 2015, but most individual infestations were small. When added together, the total area affected was about 50,000 acres of mortality. The maps in this publication represent only what is reported as mortality or defoliation and not the total infestation of a pest. In any given year, some areas are not surveyed because of 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 the 20 selected insects and diseases across multiple years. Trend data across multiple years is helpful to identify and predict insect and disease outbreaks.

Every year, hundreds of native and nonnative insects and diseases damage our Nation's forests. This report provides descriptions of 18 major insects and diseases that contribute to annual forest mortality and defoliation. Following these, the Pests To Watch section describes pests that have the potential to become a major threat and that the Forest Service and its partners are monitoring.

Mountain Pine Beetle

Dendroctonus ponderosae Hopkins

In 2015, surveys detected mountain pine beetle (MPB) mortality on approximately 1.3 million acres, a decrease of more than 400,000 acres from 2014 (fig. 1). Populations of MPB increased in some States and forests, notably California, and decreased in others (figs. 2 and 3).

Mountain pine beetle activity in the Southwestern Region is more limited than in other areas of Western North America. In addition, ponderosa pine, an important host for MPB in other regions, is rarely attacked in the Southwest despite its abundance on the landscape. In New Mexico, only occasional individual ponderosa pine trees have been observed with MPB, and no recent outbreaks have occurred. Widespread bark beetle activity in the ponderosa pine forests of the Southwest tends to be a combination of ips, western, and roundheaded pine beetles.

Since the early 2000s, most of the MPB activity in Arizona has not been observed in ponderosa pine, but in southwestern white pine, primarily following wildfires. Aerial survey data and ground surveys also found a large decline in southwestern pine mortality from MPB attacks between 2014 and 2015. In 2015, aerial surveys detected the most damage from MPB on the San Francisco Peaks, north of Flagstaff.

In the Intermountain Region, MPB-caused mortality continues to decrease. Surveys in 2015 recorded the lowest level of pine mortality in over a decade. Most of the pine mortality occurred in southern Idaho, western Wyoming, and Utah. Nearly all ownerships experienced decreased pine mortality. Most lodgepole pine mortality occurred in Idaho on the Payette, Salmon-Challis, and Boise National Forests, but at decreased levels from 2014. Ponderosa pine mortality decreased, with the majority occurring on Bureau of Land

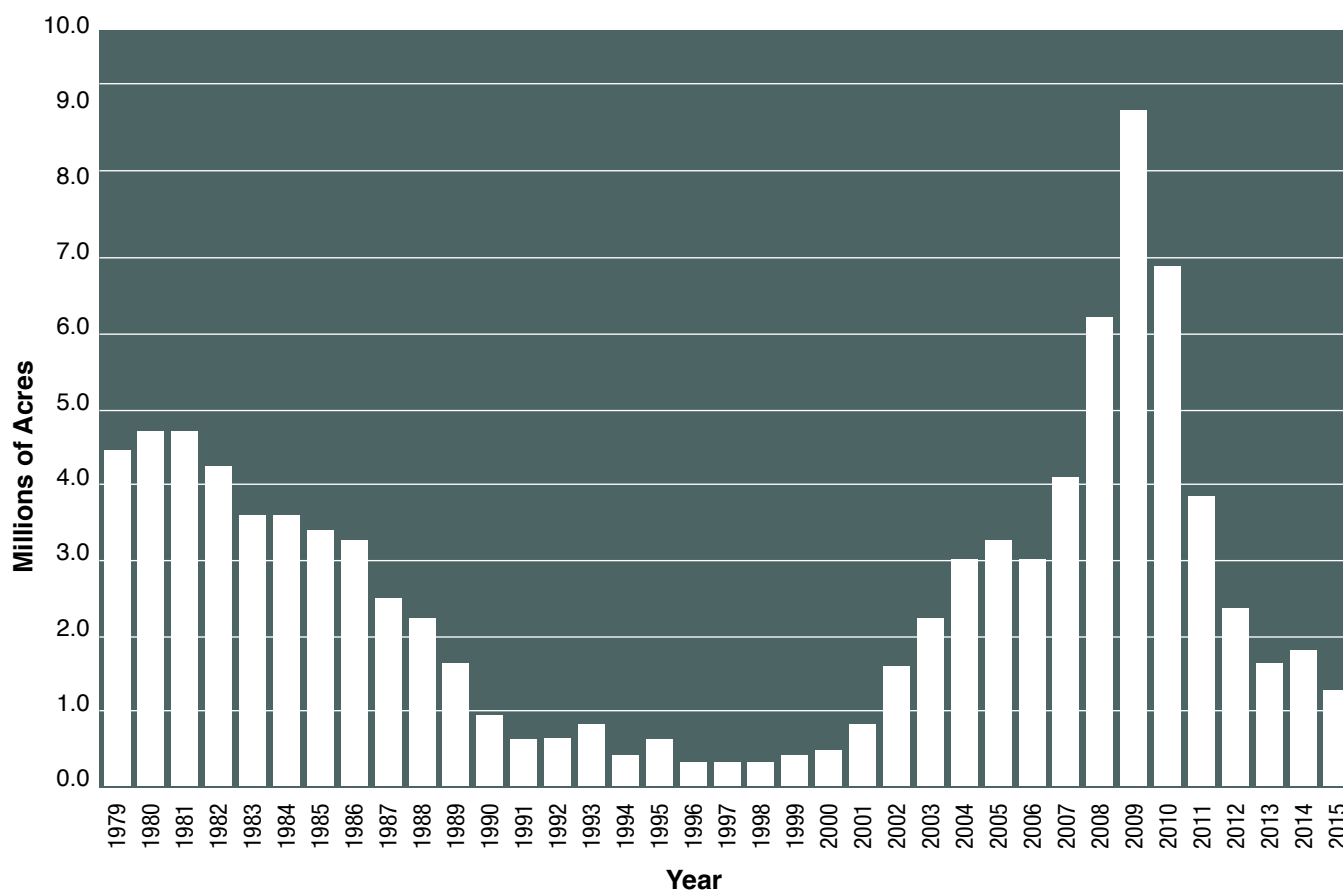


Figure 1. Mountain pine beetle activity decreased in 2015 from the previous year.

Management land in Idaho. Whitebark pine tree mortality is high, even with a nearly three-fold decrease, the majority occurring on the Bridger-Teton National Forest. Limber pine mortality increased on all ownerships in Utah and on southern Idaho national forests, but is still at endemic levels.

Sugar pine mortality increased slightly along the California-Nevada border on the Humboldt-Toiyabe National Forest in 2015. MPB-caused mortality was not reported in bristlecone or western white pine in Nevada. Drought coupled with warmer temperatures and landscapes composed of susceptible hosts are the significant factors contributing to the tree mortality caused by this bark beetle. MPB activity was up dramatically, particularly in sugar pines, on the western slope of the Sierra Nevada range. Large groups of mature sugar pines (5–20 trees) were attacked in Sequoia-Kings Canyon and Yosemite National Parks and on the Sierra and Sequoia National Forests. This is the highest level of sugar pine mortality observed in the past several decades.

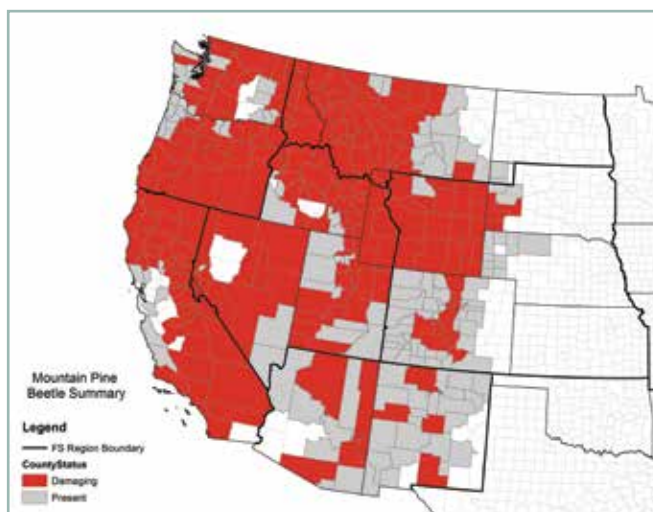


Figure 3. Counties that reported mountain pine beetle damage in 2015.

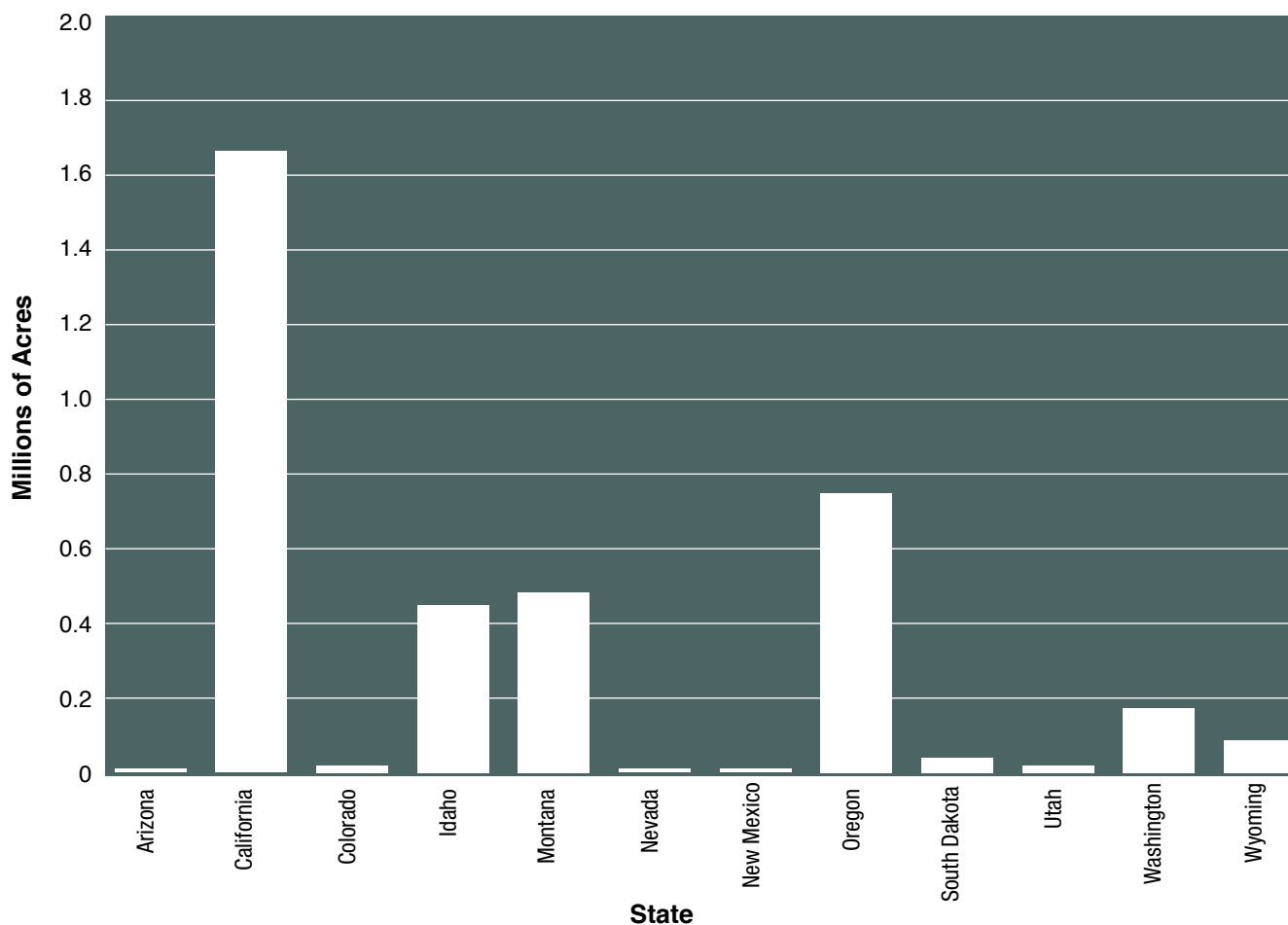


Figure 2. Mountain pine beetle-caused mortality in 2015 by State.

Mortality of pine species attributed to MPB was detected across the Northern Rocky Mountain Region in 2015, although most areas of past activity continue to decline in intensity. Despite most mortality occurring as scattered trees across a landscape containing limited susceptible host trees, some areas of significant mortality were noted, including areas with increased mortality 10 to 15 years after the initial outbreak. Lodgepole pine remains the principal host and accounts for more than 90 percent of all mortality detected.

In northern Idaho, MPB-caused mortality detected in 2015 dropped to just over half the acres detected in 2014, with decreases identified in all host types. The number of trees estimated killed varied with large decreases in western white pine and whitebark pine, a modest decrease in lodgepole pine, but a significant increase in ponderosa pine. Nearly 90 percent of all tree mortality was noted in Clearwater and Idaho Counties in lodgepole pine. Idaho County, a majority of the Nez Perce National Forest, also contained three-quarters of all ponderosa and western white pine mortality.

Mortality in Montana dropped to about one-third of 2014 acres and two-thirds of 2014 tree numbers. This drop was driven largely by decreased mortality in lodgepole and ponderosa pine; there was, however, a significant increase in white pine mortality. The number of detected recently killed trees fluctuated similarly with decreases in lodgepole, ponderosa, and high-elevation five-needle pines (white bark and limber pine) but increasing in white pine. Nearly half of all lodgepole mortality in Montana was detected in Beaverhead County, with another one-third in Missoula and Ravalli Counties. Approximately three-fifths of all mortality in the high-elevation pine habitat type also occurred in Beaverhead County with another one-fifth in nearby Granite County. Nearly two-thirds of all mortality in ponderosa was detected in Ravalli County where pine engraver activity (*Ips pini* (Say)) is also high. These counties constitute significant parts of the Beaverhead, Bitterroot, and Lolo National Forests. Nearly all mortality in western white pine in Montana occurred in Lincoln County on the Kootenai National Forest.

Areas with mortality due to MPB decreased in Oregon and Washington compared to 2014 levels. In Washington, MPB-caused mortality of lodgepole pine, ponderosa pine, and whitebark pine decreased from 2014, while mortality due to MPB increased slightly in western white pine. Concentrated areas of lodgepole and ponderosa pine mortality in Washington occurred in the Colville National Forest in northern Ferry County and central Chelan County near Lake Chelan and within the Okanogan-Wenatchee

National Forest. Large fires that burned during the summer of 2015 could contribute to the decline of MPB acres mapped in Washington. In Oregon, tree mortality due to MPB declined for the first time in 2 years. Reduced mortality may be due to the loss of lodgepole and five-needle pine (whitebark, western white, and sugar) hosts from previous MPB infestations (fig 4). Concentrated lodgepole pine mortality was most apparent in Klamath and Lake Counties in the southern part of the State and in Grant, Baker, and Malheur Counties. Significant areas in Oregon were also impacted by 2015 wildfires.

The MPB epidemic has ended in many areas of Colorado as larger pine trees have been depleted in the core outbreak areas (fig. 5). The epidemic has also ended along the southern and western fronts despite availability of susceptible host trees. Just under 4,000 acres of MPB-caused mortality were recorded in Colorado in 2015, including in high-elevation limber pines, which occur in more scattered stands than other susceptible pines. Areas of lodgepole pine mortality along the Continental Divide in southern Colorado and adjacent to spruce beetle areas is noteworthy and



Figure 5. Mortality in Colorado.

Photo by William M. Ciesla, Forest Health Management International.

may represent one or several western bark beetle species. In many areas, the typical hosts of MPB (ponderosa and lodgepole pine) are being attacked by secondary beetles, including spruce beetle, roundheaded pine beetle, and ips beetles. MPB activity in ponderosa pine stands on the southern flanks of the Uncompahgre Plateau has dwindled to very low levels. MPB activity declined considerably in the northern Front Range counties of Larimer, with 460 acres of lodgepole and ponderosa pine mortality, and Boulder, with 150 acres of high-elevation limber pine mortality (fig. 6).

MPB activity has declined across much of Wyoming. Outbreaks statewide declined consistently since peaking in 2009. However, MPB activity expanded onto about 10,000 acres that had not been previously mapped in this epidemic. Most of the expansion onto new acres occurred in high-elevation five-needle pine forests, primarily in western Wyoming. The epidemic has run out of suitable hosts in many areas across the State, but remains active in the

southern Bridger-Teton and Shoshone National Forests, as well as the Wind River Reservation. While ground surveys and brood surveys indicate the overall outbreak in the Black Hills is declining, northeastern Wyoming experienced tree mortality levels similar to 2014. North central Wyoming, including Bighorn National Forest and adjacent lands in Bighorn, Johnson, Sheridan, and Washakie Counties have large areas of forest that remain unaffected, yet susceptible, to MPB in this area.

Analysis of brood samples, ground transects, and high-resolution aerial photography of the Black Hills of South Dakota and northeastern Wyoming reveals that the MPB epidemic is slowing overall, although populations remain static or show slight increases in localized areas. Group mortality in excess of 1,000 trees per location was observed in some areas. An estimated 4,000 trees were infested in Custer State Park from the 2015 flight. This is a significant reduction from the previous year.



Figure 6. Old mountain pine beetle mortality, Williams Fork Basin, CO.
Photo by William M. Ciesla, Forest Health Management International.

Gypsy Moth

Lymantria dispar Linnaeus

Across the North and Northeast, surveys detected 1.5 million acres of gypsy moth (GM) defoliation in 2015, a nearly four-fold increase from 2014 (figs. 1 and 2). Gypsy moth populations decreased in some areas, while other areas experienced a significant increase (table 1). Much of this variability was the result of varying amounts of cool weather and precipitation, which in turn impacted the prevalence of the caterpillar-killing fungus, *Entomophaga maimaiga*.

In Connecticut, GM-caused defoliation was heaviest in Middlesex and New London Counties. There was also combined damage due to both GM and winter moth in southern New London County. Defoliation was mapped by aerial survey in the following Massachusetts counties: Barnstable, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, and Worcester. Heavy defoliation occurred mostly east of Interstate 495 and surrounding the Quabbin Reservoir.

Acres of forest damage from GM increased dramatically in southeast New York in 2015. Defoliation, discoloration,

and mortality were mapped by aerial survey in Dutchess, Orange, Putnam, Rockland, Suffolk, Sullivan, Ulster, and Westchester Counties.

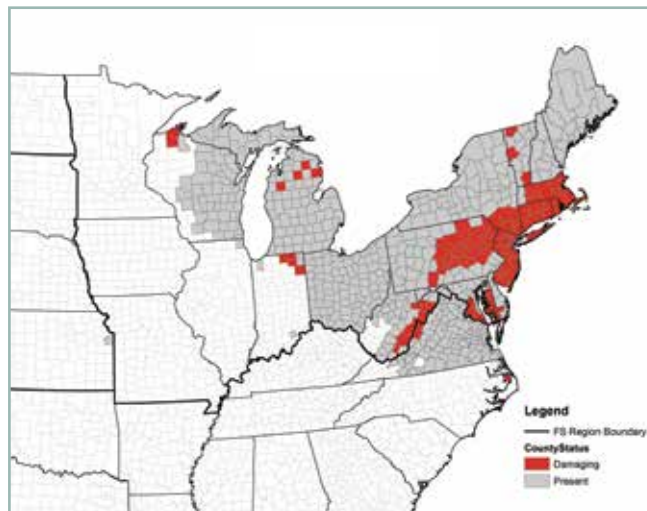


Figure 2. Counties that reported gypsy moth defoliation in 2015.

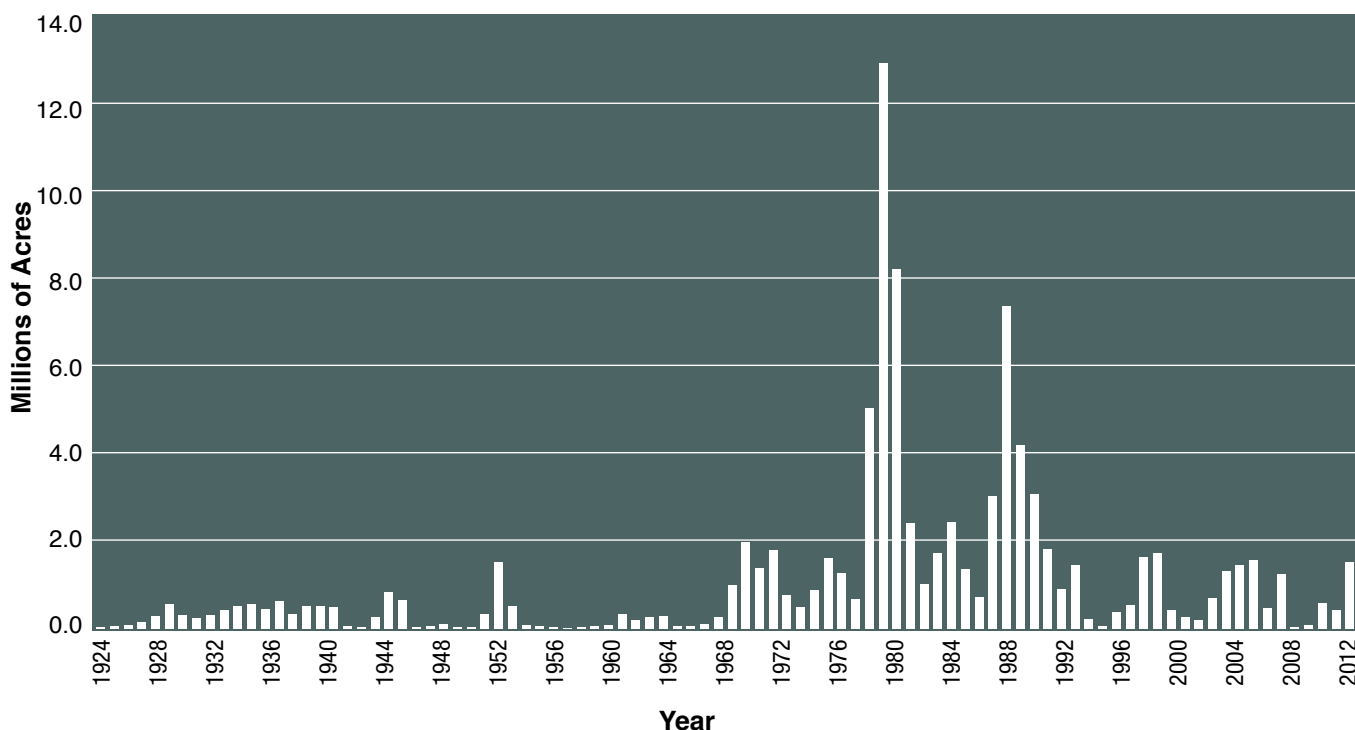


Figure 1. Gypsy moth defoliation from 1924 through 2015.

Table 1. Gypsy moth defoliation by State in 2015.^{1, 2}

| State | Acres |
|---------------|-----------|
| Connecticut | 179,298 |
| Maryland | 596 |
| Massachusetts | 100,114 |
| Michigan | 915 |
| New Jersey | 285,728 |
| New York | 97,016 |
| Pennsylvania | 694,109 |
| Rhode Island | 46,795 |
| Virginia | 8,533 |
| West Virginia | 100,205 |
| Total | 1,513,308 |

¹Data derived from the Insect and Disease Survey (IDS) national database.

²There is no multiple counting of acres within a State or between States.

In Rhode Island, there was some severe, highly localized defoliation in 2014 (as in years past), especially in Providence and Kent Counties, but during the statewide egg mass survey conducted in the fall and winter of 2014–2015, there was no significant increase in the number of egg masses found over prior years, and little reason to suspect an infestation of the extent experienced that spring. Defoliation was mapped by aerial survey in all Rhode Island counties, but the acreage numbers may underrepresent actual damage, as understory canopy defoliation was widespread but not detectable through aerial survey methods. The astronomical number of egg masses observed in 2015 forewarn of an even more significant outbreak in 2016.

No major defoliation was found in New Hampshire in 2015, but reports of caterpillar activity in the spring increased. Vermont reported light defoliation in Addison, Franklin, and Windham Counties, and egg mass counts were very low. No defoliation was recorded in Maine; this is down from the 8 acres of defoliation resulting from GM larval feeding recorded in 2014 in Orient (Aroostook County). Egg mass scouting in 2015 did not uncover GM establishment in any new areas.

In Maryland, GM populations decreased across the State, where conditions were very favorable for *E. maimaiga*. Populations decreased in Garrett and Allegany Counties where the majority of the suppression has occurred the last few years. Defoliation occurred in Caroline, Queen Anne's, St. Mary's, and Charles Counties. Gypsy moth activity increased significantly in New Jersey, where the majority of defoliation was seen in the northern part of the State.



Figure 3. Defoliation in Menominee County, WI. Photo by Bill McNee, Wisconsin Department of Natural Resources.

In Pennsylvania, oak forests consisting of chestnut oak, northern red oak, white oak, and black oak in the central and eastern part of the State were defoliated entirely by GM along with other earlier season defoliators, including fall cankerworm and oak leaf-roller. Although GM is present in all counties in Delaware, aerial surveys did not detect any damage in 2015.

Gypsy moth populations collapsed across the central-northern Lower Peninsula of Michigan. Some defoliation was mapped but at greatly reduced levels than was reported in 2014. In Indiana, no GM defoliation was detected by aerial survey; however, reports of defoliation were received from landowners in Allen, Elkhart, Lagrange, and Noble Counties. Defoliation was detected in Bayfield County, WI. Fifty of Wisconsin's 82 counties are now infested by GM, and the quarantine was expanded to Taylor County (fig. 3). No defoliation damage was reported in Iowa, Illinois, Minnesota, Missouri, or Ohio.

After 5 years of virtually no detectable GM damage in Virginia due to cool, wet spring weather, 2015 saw the first detectable defoliation event large enough to map in the western part of the State. Moderate to heavy defoliation was reported at the State's border with West Virginia along Route 84 (Highland and Bath Counties). The eastern counties of Grant, Hardy, Pendleton, Pocahontas, and Summers in West Virginia recorded nearly 100,000 acres of defoliation in 2015.

In North Carolina, a large outbreak occurred in Buxton (Dare County).

Southern Pine Beetle

Dendroctonus frontalis Zimmermann

In 2015, surveys showed an almost 14-fold increase in acres with southern pine beetle (SPB) activity throughout the South and East (figs. 1 and 2), though activity continues to occur on under 50,000 total acres in 9 States (table 1).

SPB infestations in Mississippi were significant for the 4th consecutive year, primarily on national forest lands. The most recent activity occurred primarily on the Bienville National Forest and some surrounding private forestland, with continuing but lesser amounts on the Homochitto National Forest. Significant SPB activity was not limited to Mississippi this year, but was also present in Alabama. Aerial detection flights across all 67 Alabama counties revealed 378 spots; more than 75 percent of these spots were concentrated in three counties in southwest Alabama: Choctaw, Clarke, and Marengo. While drought conditions were not severe across most of Alabama, significant drought

did impact the southwest portion of the State near the Mississippi State line, so this concentration of spots was initially thought to be due primarily to ips beetles associated with drought conditions. However, ground checks revealed that most of the spots contained a combination of SPB and ips activity.

In Virginia, ongoing SPB activity has continued south of Virginia Beach and on Chincoteague/Assateague Islands along the Eastern Shore. This activity has been ongoing for several years or more and is associated with very mature stands of loblolly growing on challenging sites impacted by past storms and saltwater intrusion. Across the remainder of the Southern Region, there were scattered reports of isolated SPB activity, all of which were unremarkable in extent.

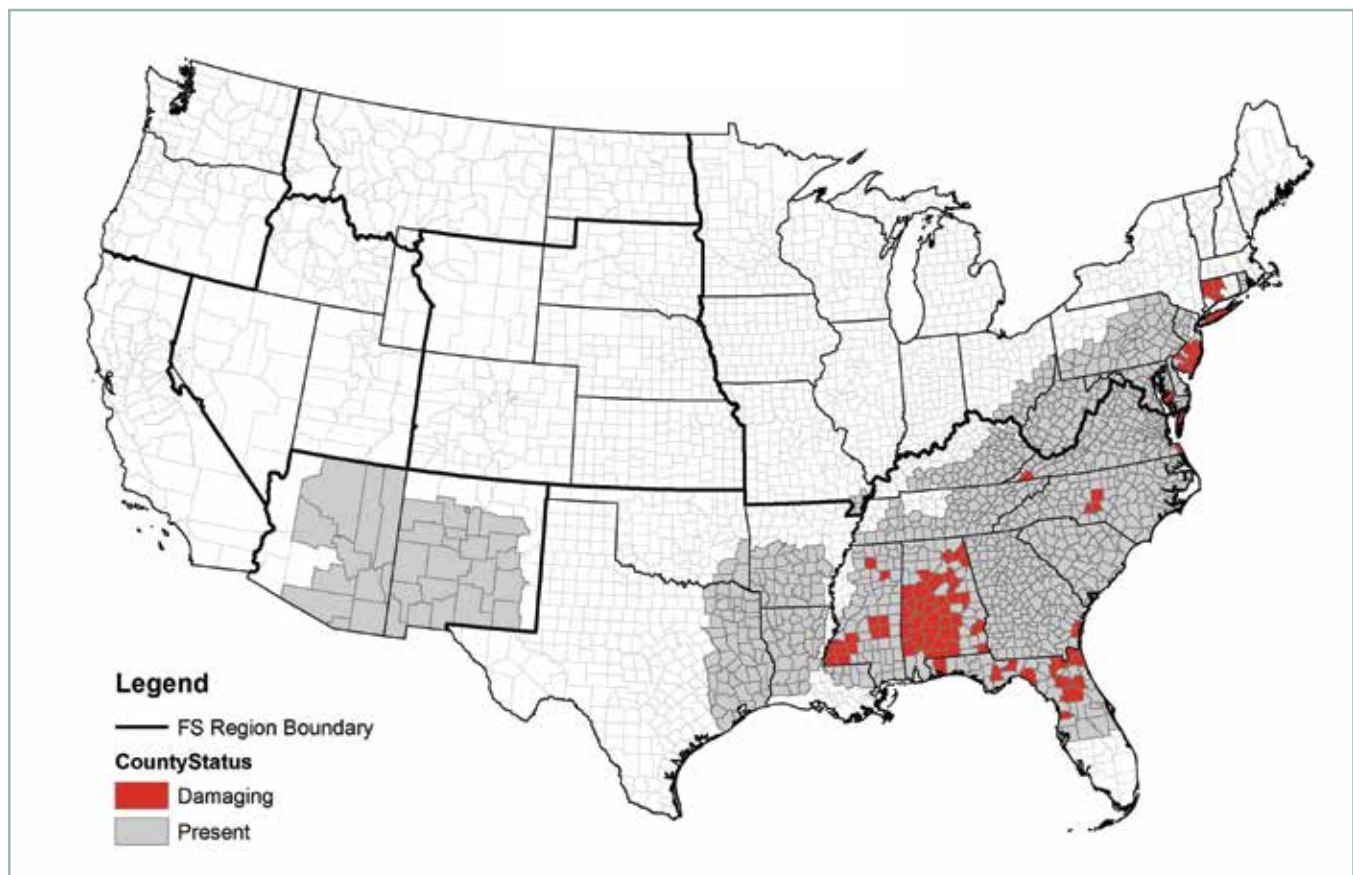


Figure 1. Counties that reported southern pine beetle infestations in 2015.

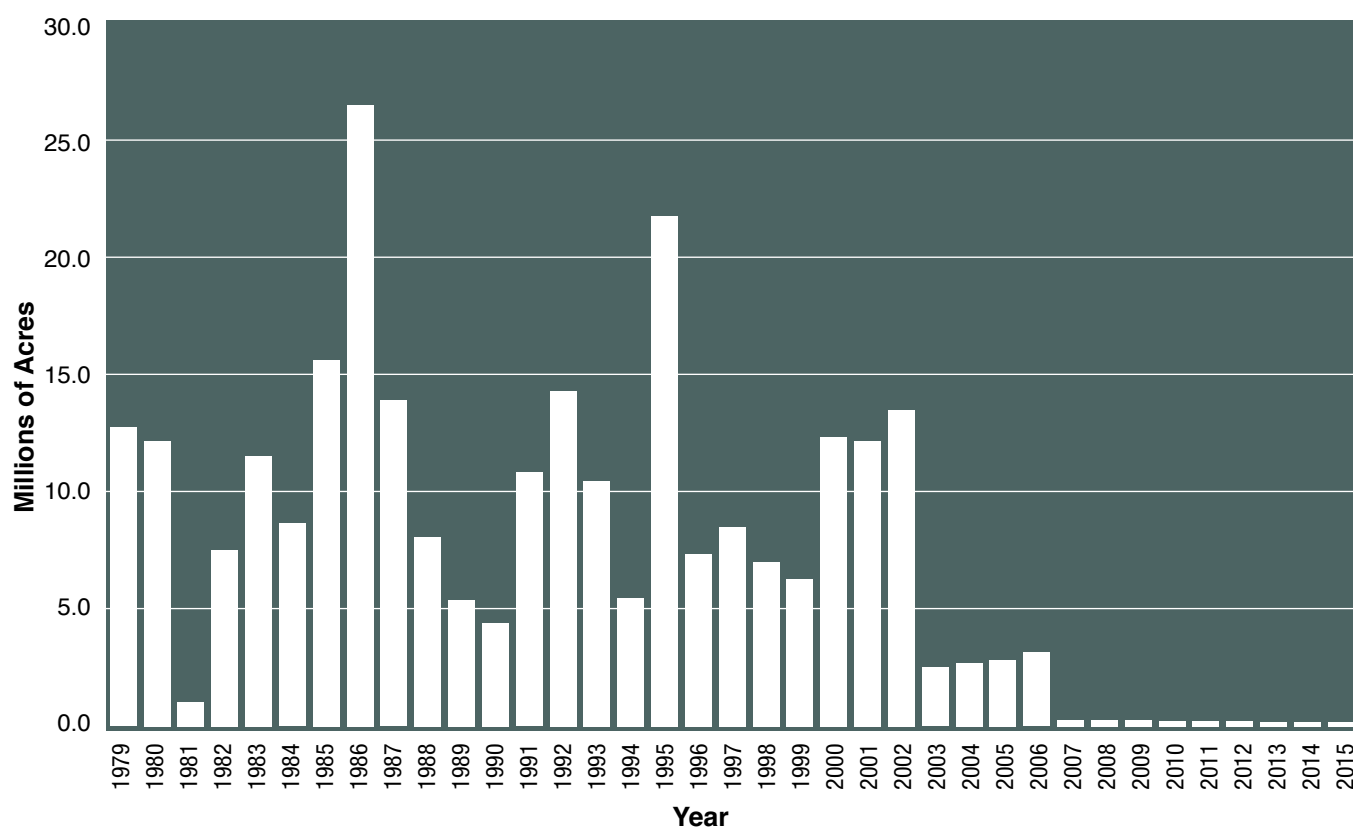


Figure 2. Southern pine beetle (SPB) outbreaks, 1979 to 2015. Note: The surveys after 2007 counted the number of outbreak acres differently than in previous years. All acres in the county previously were counted if a single spot was positive for SPBs. The surveys after 2007 reflect the estimated number of areas affected by SPBs.

Table 1. Southern pine beetle activity by State in 2015.^{1,2}

| State | Acres |
|----------------|--------|
| Alabama | 190 |
| Florida | 62 |
| Georgia | 72 |
| Maryland | 136 |
| Mississippi | 286 |
| New Jersey | 5,207 |
| New York | 34,000 |
| North Carolina | 1,202 |
| Virginia | 75 |
| Total | 41,230 |

¹Data derived from the Insect and Disease Survey (IDS) national database.

²Spot information from aerial and ground surveys reported in SPB Data Portal.

In the Northeastern Area, SPB has historically been found in Delaware, Maryland, Ohio, and West Virginia (fig. 3). In the 1990s, infestations were found in New Jersey, and in 2014, infestations were found for the first time in New York. SPB impacts have been concentrated in the southern portion of New Jersey; however, populations appear to be moving north, particularly along the eastern coast. SPB is surveyed by aerial detection and select ground verifications. In New Jersey, SPB mainly affects pitch pine (*Pinus rigida*), shortleaf pine (*P. echinata*), and Virginia pine (*P. virginiana*) but has been observed infesting Norway spruce (*Picea abies*) and white pine (*Pinus strobus*).

In New York, this insect was first observed in Suffolk County in the fall of 2014. Since that time, several aerial surveys, ground surveys, and trapping efforts have detected the beetle and its damage throughout most of the pine barrens of Long Island (Nassau and Suffolk Counties). Pitch pine, white pine, and Norway spruce all have been killed, and it has been estimated that there may be as many as 40,000 infested pines on Long Island at the present time (fig. 4).



Figure 3. Southern pine beetle damage.

Photo by USDA Forest Service.

SPB was detected for the first time in Connecticut in 2015 (Hartford, Litchfield, and New Haven Counties), affecting red pine (*Pinus resinosa*) and black pine (*P. nigra*). In the spring of 2015, SPB was identified for the first time in Rhode Island (Providence, Kent, and Washington Counties).

In Delaware, SPB traps at Cape Henlopen State Park trapped large numbers of beetles with no observed tree damage, as in recent years. An aerial survey detected old mortality at Assawoman Bay State Wildlife Area and a spot of 2- to 3-year-old mortality along Herring Creek on the north edge of Rehoboth Bay (five pine trees).

More than 135 acres of dead loblolly pine in Dorchester County, MD, were detected in 2015. Approximately 300 acres of SPB damage has been observed on Assateague Island National Seashore in 2015. Damage is occurring in mature, salt-intrusion-stressed loblolly pine trees.

There was no reported damage from SPB in Ohio in 2015.



Figure 4. Pitch tube damage by southern pine beetle.

Photo by Erich G. Vallery, USDA Forest Service.

Emerald Ash Borer

Agrilus planipennis Fairmaire

As of the end of 2015, emerald ash borer (EAB) was known to occur in 25 States and the District of Columbia. It has been found in every Northeastern Area State except Maine, Vermont, Rhode Island, and Delaware (fig. 1). EAB activity was detected in nearly 2.5 times as many total acres as compared to 2014.

Tolland County, CT, was a new detection of EAB in 2015. There was significant damage only in New Haven County, where dead and declining trees were mapped by aerial survey in 2015.

In 2015, there were new EAB-positive finds in 10 counties in Illinois. EAB has spread throughout the State, and as a result, Illinois Department of Agriculture has dropped the internal EAB quarantine. Illinois will remain part of a Federal quarantine.

In Indiana, there was one new county record in 2015; visual surveys of uninfested, quarantined counties detected EAB in Parke County. An aerial survey mapped the western and southern edge of the EAB mortality area that is expanding from the infested northeastern quarter of the State. The aerial survey also mapped mortality expansion in south-central Indiana, and the beginning of mortality in southeastern Indiana and along the Ohio River to Clark and Floyd Counties. The survey also noted the start of mortality in Sullivan and Vigo Counties in west-central Indiana; a small area in Owen County; and along the Tippecanoe and Wabash Rivers in Carroll, Tippecanoe, and White Counties.

EAB is widespread in Iowa, and a statewide quarantine was issued on February 4, 2015.

Tree mortality was reported in Frederick County, MD, and areas from Hagerstown (Washington County) to west of Cumberland (Allegany County).

Emerald ash borer was first found in Massachusetts in late August 2012 in the town of Dalton. Delineation surveys were conducted in 2015 to help define the current boundaries of the infestation throughout the State. Surveys have currently estimated the infestation in Berkshire County to still be moderate in size, approximately 20 square miles. The EAB infestation found in 2013 in Essex County in the northeast part of the State had minimal spread-out

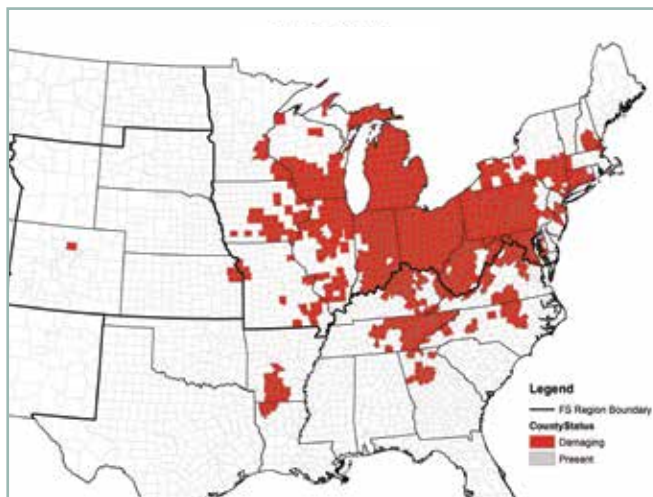


Figure 1. Emerald ash borer-caused mortality in 2015. (Note: In the absence of a current report, a county previously listed as “damaged” remains as such.)

from the initially mapped infestation area. The Arnold Arboretum infestation in Boston, Suffolk County, has not been delineated as of November 2015. Infested counties in Massachusetts include: Berkshire (the municipalities of Dalton, Pittsfield, Hinsdale, Washington, Windsor, Hancock, Lee); Essex (the municipalities of North Andover, Methuen, and Haverhill); and Suffolk (City of Boston).

There were no new county records in Michigan in 2015. The Lower Peninsula is generally infested. In the Upper Peninsula, EAB is found in several counties and is expected to continue spreading through the ash resource in 2016.

In Minnesota, there has been a recent increase in the number of counties infested with EAB, and there were several new county records in 2015: Anoka, Chisago, Dakota, Fillmore, Hennepin, Houston, Olmsted, Ramsey, Scott, St. Louis, Washington, and Winona. The spread of EAB in Minnesota has been much slower than the rate of spread in most other infested States, when comparing the percentage of counties infested with EAB with the number of years of infestation.

New county records for Missouri were reported from: Buchanan, Marion, Oregon, and St. Louis Counties and St. Louis City. All of the 2015 detections were made by alert green-industry or municipal professionals. Additional detections in 2015 were made with EAB traps and included

an Oregon County site in southeastern Missouri and multiple locations in Buchanan County, just to the north of the positive Kansas City area counties.

New outbreaks have been found in Belknap County, New Hampshire.

In New Jersey, EAB was positively identified in Bergen (Hillsdale Borough), Burlington (Edgewater Park Township), Mercer (Hamilton Township, Princeton Township, Hopewell Borough, West Windsor Township), Middlesex (Monroe Township, South Brunswick Township), Monmouth (Allentown Borough), and Somerset (Franklin Township) Counties. All of these finds were through trap catches or adult insect finds. The entire State is included under the Federal EAB quarantine.

Emerald ash borer continues to cause significant mortality throughout its range in New York. In 2015, the State quarantine on EAB was redrafted in an attempt to slow the spread within the State. There are 14 separate “restricted zones” within which EAB has been confirmed. Schenectady County was the only new county confirmed infested for the first time in 2015 and will become part of the Albany-

Rensselaer restricted zone. Ash mortality was mapped by aerial survey in Ulster and Wyoming Counties.

Mortality due to EAB was detected mainly in central and northeast Ohio during the annual aerial survey; western and northwestern Ohio were not flown in 2015. Four new counties reported EAB infestations: Carroll, Gallia, Morgan, and Ross. EAB continues to spread throughout the State, with increasing populations in new counties. In late 2014, EAB was discovered to be infesting white fringetree (*Chionanthus virginicus*), a member of the olive family, along with ash. Monitoring of native and planted white fringetree in Ohio is ongoing.

Ash dieback and mortality were observed across Pennsylvania in 2015 (57 of 67 counties). Two new counties were confirmed (Lancaster, McKean) in 2015.

Infestations of EAB have now been found in 34 counties in Wisconsin, with five additional counties quarantined due to being surrounded by infested counties or a detection close to the border. In 2015, new records were reported for Outagamie, Marquette, Jackson, Richland, Lafayette, and Green Counties. The core of the EAB population remains



Figure 2. Mortality in southeast Wisconsin.

Photo by Bill McNee, Wisconsin Department of Natural Resources.

in the southeastern part of the State, and scattered ash tree mortality is limited to this area (fig. 2).

EAB continues to spread in West Virginia. New counties infected with EAB in 2015 include Cabell, Grant, Harrison, Marion, Marshall, Pendleton, Preston, Taylor, Tyler, Upshur, Wayne, and Wetzel.

As EAB has been found in multiple locations near Maine's borders, the State continued multi-tiered monitoring and no insects were found. Monitoring conducted using trap catches, trap trees, ground surveys, biosurveillance, and outreach has also not detected EAB in Vermont.

In Virginia, nine new counties reported EAB in 2015: Clarke, Rappahannock, Madison, Rockingham, Rockbridge, Botetourt, Bland, Lunenburg, and Westmoreland. Forty-eight new spots of EAB damage were reported in 2015 (fig. 3). Given that ash mortality is now widespread in many counties, the number of reported acres surely underestimates actual damage throughout the State.

New infestations of EAB were confirmed in Kentucky in Bullitt, Clark, Floyd, Harlan, Lincoln, Madison, Martin, Mercer, Montgomery, Nelson, Spencer, and Washington Counties in 2015, for a total of 52 counties with confirmed EAB infestations.

In Tennessee, 7 new counties were added to the list in 2015, for a total of 46 infested with EAB.

In 2015, EAB was confirmed in 14 additional North Carolina counties. Detections were made via traps, survey by ground and water, and by *Cerceris* biosurveillance program. As a result of the increase in findings and their scattered distribution, the entire State was placed under quarantine.

In Georgia, EAB spread to 7 additional counties in 2015 (Barrow, Cherokee, Douglas, Fannin, Habersham, Murray, White), bringing the total to 19. The Georgia Forestry Commission and the Georgia Department of Agriculture have consequently widened the quarantine to include all new counties and have regulations regarding the movement of unprocessed ash logs and firewood from the regulated areas.

In Arkansas, EAB was confirmed in 10 counties in 2015. The most obvious damage is found in Ouachita County. A quarantine on the movement of ash and hardwood firewood was established, encompassing the 10 confirmed counties and 19 additional buffer counties.



Figure 3. Emerald ash borer larvae seen in tunnels on damaged ash tree, Virginia.

Photo by Eric R. Day, Virginia Polytechnic Institute and State University.

In Louisiana, EAB was first confirmed in Webster Parish in February of 2015. It has since been confirmed in Bossier and Claiborne Parishes. An official quarantine is in effect for those three parishes.

In 2015, Kansas expanded the EAB quarantine to include Douglas County and Jefferson County, the fourth and fifth counties with confirmed EAB presence—all contiguous in the Kansas City area. In both counties, girdled trap trees were peeled in October, with live EAB larva extracted from beneath the bark. EAB was confirmed in the communities of Eudora and Lawrence and at the U.S. Army Corps of Engineers property at Lake Perry. In previously quarantined counties (Johnson, Leavenworth, and Wyandotte), ash tree mortality was observed to increase over previous years.

Emerald ash borer continues to be confirmed only within Boulder County in Colorado. To date, the city of Boulder has declared a state of general infestation and has shifted focus from delimiting survey to tree treatment, removal, and replacement.

Sudden Oak Death

Phytophthora ramorum Werres et al.

Sudden oak death (SOD) continued to cause mortality in tanoak and susceptible oak species in California and Oregon in 2015, and twice as many acres were affected compared to 2014 (fig. 1). In California's 15 infested coastal counties, the ongoing drought moderated SOD impacts, with fewer infested areas detected by aerial surveys in 2015 than in recent years. Where environmental conditions were conducive to pathogen establishment and intensification, high levels of infection continued to manifest, such as in the coastal mountains of Santa Cruz and Sonoma Counties. Where the pathogen is established in the drier east, relatively little new mortality was detected (fig. 2).

Newly infested watersheds in California were limited to the north coast, including five locations in Humboldt County and two in Mendocino County, all of which were relatively close to watercourses previously known to be



Figure 1. Counties that reported sudden oak death in 2015.



Figure 2. Sudden oak death symptoms.
Photo by Joseph O'Brien, USDA Forest Service.

infested (fig. 3). The most significant of these finds was in Redwood Creek (Humboldt County), about 9 miles upstream of the nearest known infestation in the watershed.

SOD was found infecting five new host plants in California forests in 2015: chinkapin (*Chrysopsis chrysophylla*), chaparral-pea (*Pickeringia montana*), Bolinas manzanita (*Arctostaphylos virgata*), Eastwood's manzanita (*Arctostaphylos glandulosa*), and the native California blackberry (*Rubus ursinus*). Symptoms varied from leaf spots to branch dieback; no mortality was observed.

In the more consistent environmental conditions of coastal Oregon, SOD was observed affecting part of the Winchuk River watershed only 1.5 miles north of the Del Norte County, CA, border. In 2015, another clonal lineage of *P. ramorum* (EU1) was detected on two sites on private lands near the Pistol River. This is the first report of the EU1 lineage in U.S. forests and is of particular concern because, in Europe, the EU1 lineage kills or damages several conifer tree species and is considered more aggressive than the North American lineage (NA1). Furthermore, establishment of the EU1 lineage would create the potential for increased variability in the North American *P. ramorum* population. Any EU1 sites should be considered high priority for thorough treatment.



Figure 3. Phytophthora ramorum canker on California Coast Live Oak.

Photo by Bruce Moltzan, USDA Forest Service.

Spruce Beetle

Dendroctonus rufipennis Kirby

In 2015, spruce beetle (SB) continued to cause damage in the Southwest, Northern, Intermountain, Rocky Mountain, and Pacific Northwest Regions, as well as in Alaska (fig. 1).

In Arizona, only endemic levels of SB-caused tree mortality are occurring in high-elevation spruce-fir forests. A few individual dying spruce trees were mapped in the White Mountains of eastern Arizona, north of the Grand Canyon and on the San Francisco Peaks north of Flagstaff. However, light to severe levels of spruce defoliation caused by the spruce aphid have also been occurring in the White Mountains, and it is unknown whether this activity may facilitate an SB outbreak.

In New Mexico, tree mortality in the spruce-fir type increased substantially in 2015, as recorded during aerial detection surveys. The Santa Fe National Forest had more than two-thirds of the SB activity with most of the remaining activity on the Carson National Forest. Some activity was noted on the Tres Piedras Ranger District of the Carson National Forest adjacent to the Colorado border, near where a large SB outbreak has been occurring on the Rio Grande and San Juan National Forests. As in the past few years, activity in New Mexico has primarily been in the Pecos Wilderness within the Sangre de Cristo Mountains. Ground-checking of spruce mortality on Elk Mountain on the Pecos/Las Vegas Ranger District of the Santa Fe National Forest found SB has caused 10 percent to greater than 50 percent spruce mortality in the affected stands.

Additionally, suspected SB activity was observed on Sierra Blanca in the southern portion of the State.

SB-caused tree mortality increased in the Intermountain Region for the fourth consecutive year (fig. 2). Most of the spruce mortality was mapped in Utah, where it was detected at some level on all national forests and most other ownerships. The Uinta-Wasatch-Cache, Ashley, and Fishlake National Forests have significant outbreaks. Spruce mortality on private lands in Utah decreased slightly. The increase in SB-caused tree mortality is a result of continued drought and high beetle populations in dense spruce stands. SB-caused mortality in Wyoming decreased by about 5,000 acres in 2015. In Idaho, SB-caused mortality increased and was reported on all forests and most ownerships.

In Alaska, SB activity was observed on roughly double the area that was observed in 2014. Although activity mapped in 2015 remains low compared to historical numbers, SB remains the leading non-fire cause of spruce mortality in the State. The bulk of the increase in SB damage appears to be concentrated primarily in the Yentna and Susitna River Valleys and the northwestern Kenai Peninsula. Several new areas of activity were noted in these locations, as well as in western and southeast Alaska. Widely scattered small pockets of SB activity continue to be observed in northwestern Alaska, along the Noatak, Squirrel, Omar, and Kobuk Rivers. In southeast Alaska, damage on Kupreanof

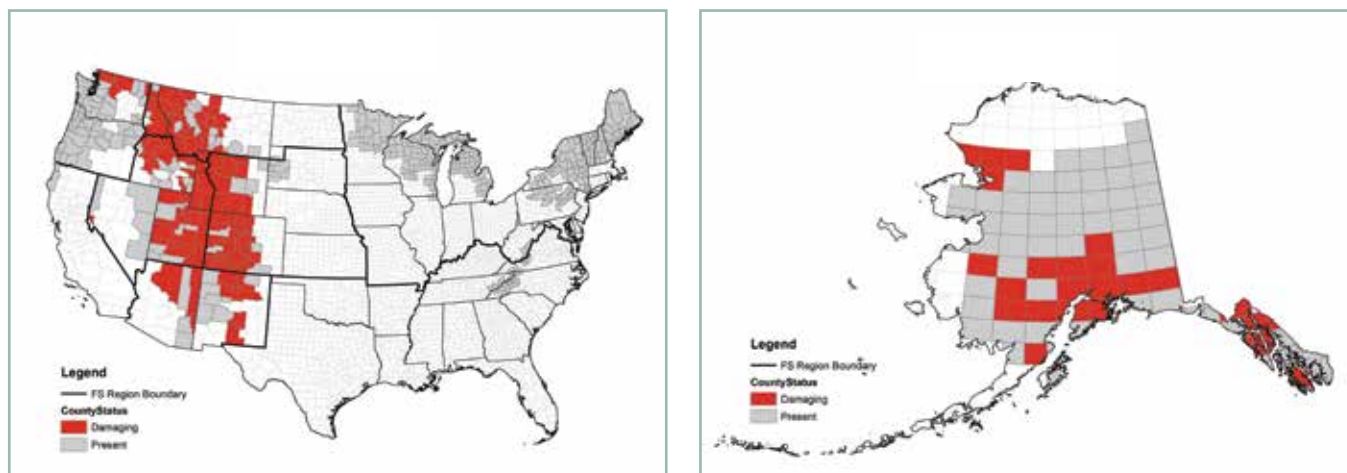


Figure 1. Counties that reported spruce beetle mortality in 2015.



Figure 2. Spruce beetle damage.

Photo by Steven Munson, USDA Forest Service.

Island previously attributed to SB (2012–2014) was determined to have been in error.

Regional area estimates for SB-caused mortality in Montana and northern Idaho remained constant, causing low levels of mortality in 2015, as occurred in 2014. Beetle populations remained endemic throughout the majority of the area. There were two substantial SB outbreaks that caused substantial mortality from 2010 to 2013, then declined sharply to low levels in 2014. These were located on federally managed lands within the Gravelly Mountains, Beaverhead-Deerlodge National Forest, and within the Rock Creek drainage, Custer National Forest. Ground surveys indicated populations remained at post-epidemic levels in 2015, where beetles only colonized scattered individual trees. SB populations are not expected to erupt again within these locations as the prevalence of susceptible, large-diameter spruce host has been substantially depleted.

In north-central Washington, the levels of mortality attributed to SB declined from 2014 levels. The majority of mortality has occurred in western Okanogan and eastern Whatcom Counties. The most significant damage detected in 2015 was in the vicinity of the Pasayten Wilderness area and the Loomis State Forest, where SB has been active since 1999.

The SB epidemic continues to expand in Colorado, most rapidly in the southern forests, where it impacts thousands of acres. Areas affected are found from the La Garita Wilderness Area to north of Cottonwood Pass, the Sangre de Cristo and Wet Mountains, as well as south to the Colorado border into New Mexico. Aerial survey in south-central Colorado showed SB epidemics expanded on the San Juan, Rio Grande, Gunnison, and San Isabel National Forests and adjacent land ownerships. The Alpine Plateau and other spruce stands between Gunnison

and Montrose, CO, have been especially hard hit recently. Activity has also increased substantially in the Sangre de Cristo Mountains, east of the San Luis Valley. Scattered activity continues on the western end of the White River National Forest. Ground surveys near the Continental Divide in southern Colorado show what may be SB killing lodgepole pine in areas near infested spruce stands. SB populations are exceptionally high in some of the more recently affected areas. Unexpected activity, including attack of now-suitable hosts (especially lodgepole pine) and very small spruce (down to 1 inch in diameter), is indicative of the very high population levels. In northern Colorado, SB caused new tree mortality from the Rabbit Ears Range and east through the southern Medicine Bow Mountains and into northern Rocky Mountain National Park in Grand, Jackson, and Larimer Counties.

SB activity declined in 2015 across Wyoming, and new spruce mortality was attributed to expansion to previously uninfested acres. SB activity is localized and increased in portions of the Wind River Range. North-central Wyoming, including the Big Horn Mountains in Big Horn and Sheridan Counties, had only small pockets of SB activity. South-central Wyoming, including Medicine Bow National Forest and adjacent lands in Carbon and Albany Counties, saw no new acres infested, but additional SB mortality was observed on localized sites where activity has previously been detected.

Western Bark Beetles

Numerous Species

Western bark beetle (WBB) mortality decreased by about 300,000 acres in 2015, and a total of about 3.6 million acres of WBB-induced mortality was reported (fig. 1). This includes mountain pine beetle and spruce beetle, which have been discussed in previous sections. The following sections describe the conditions of other selected WBB reported for 2015 (table 1).

Douglas-Fir Beetle

Dendroctonus pseudotsugae

Douglas-fir beetle (DFB)-caused mortality decreased from 192,284 acres in 2014 to 138,826 acres in 2015 (fig. 2).

Total WBB-caused mortality observed in the mixed conifer forests across the Southwest declined substantially in 2015 from 2014, notably in white fir. Douglas-fir mortality caused by DFB also decreased across the Southwest.

Douglas-fir mortality in Arizona essentially stayed the same as the amount observed in 2014, with most of the activity in the White Mountains, within the half-million-acre Wallow Fire of 2011. This fire facilitated huge population increases of DFB because of the number of fire-injured trees on the landscape. DFB activity has been monitored within the fire perimeter using funnel traps with pheromone lures, aerial surveys, and ground surveys in selected areas since 2012. In 2015, most of the indicators showed that beetle populations

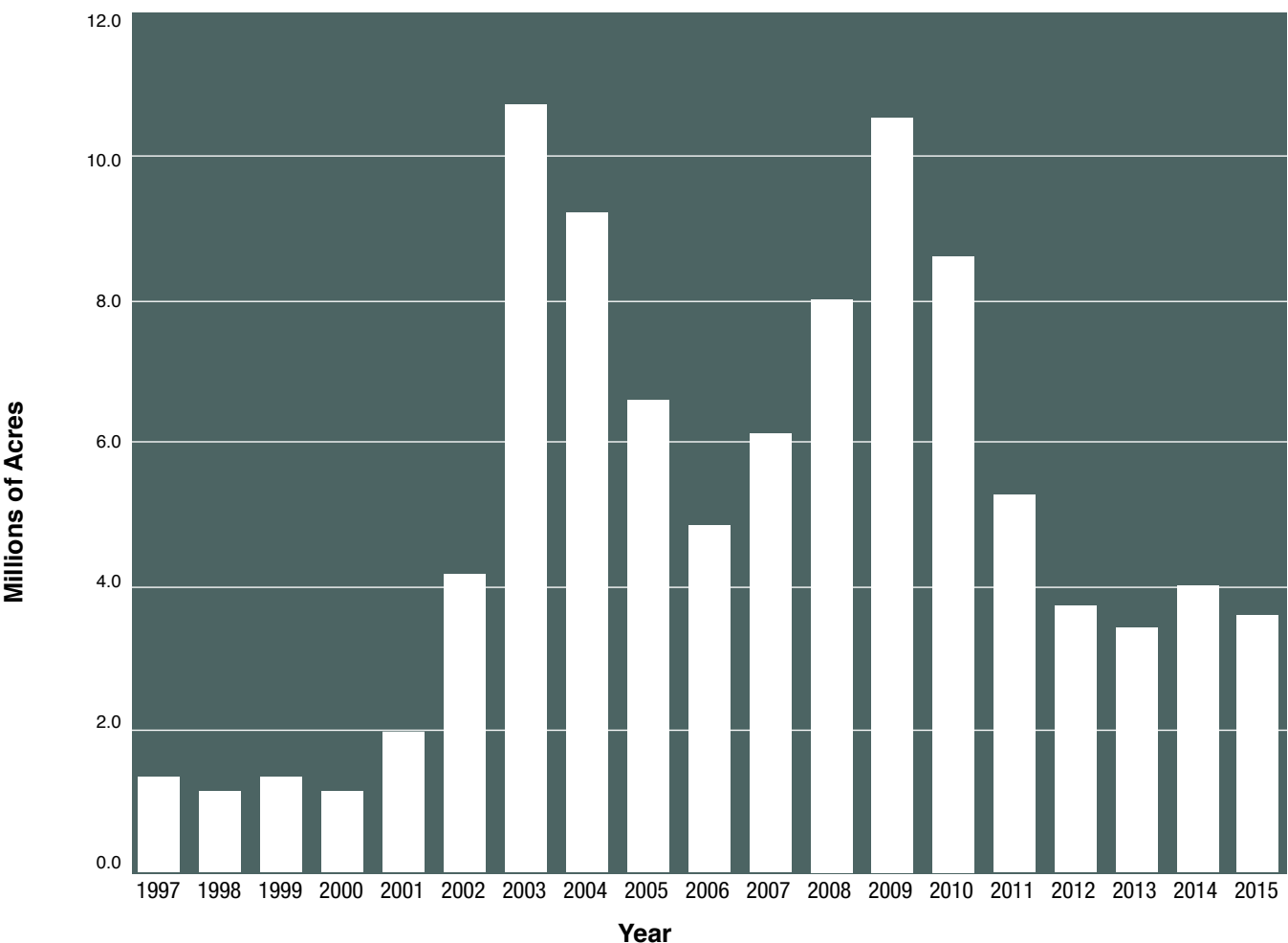


Figure 1. Western bark beetle damage from 1997 to 2015.

Table 1. Selected western bark beetles and infested acres detected in aerial surveys during 2015.

| Bark Beetle(s) | Host(s) | Acres Detected with Bark Beetle Activity in 2015 ¹ |
|--|---|---|
| Mountain pine beetle, <i>Dendroctonus ponderosae</i> Hopkins | Ponderosa pine (<i>Pinus ponderosa</i> C. Lawson), lodgepole pine (<i>P. contorta</i> Douglas ex Louden), white pines, and others (<i>Pinus</i> spp.) | 1,320,444 acres |
| Spruce beetle, <i>Dendroctonus rufipennis</i> (Kirby) | Engelmann spruce (<i>Picea engelmannii</i> Parry ex Engelm.), white spruce (<i>P. glauca</i> [Moench] Voss), Sitka spruce (<i>P. sitchensis</i> [Bong.] Carr.) | 660,594 acres |
| Douglas-fir beetle, <i>Dendroctonus pseudotsugae</i> Hopkins | Douglas-fir (<i>Pseudotsuga menziesii</i>) | 138,827 acres |
| Jeffrey pine beetle, <i>Dendroctonus jeffreyi</i> Hopkins | Jeffrey pine (<i>Pinus jeffreyi</i> Balf.) | 762,485 acres |
| Western pine beetle, <i>Dendroctonus brevicornis</i> LeConte | Ponderosa pine, Coulter pine (<i>Pinus coulteri</i> D. Don) | 718,407 acres |

¹The number of dead trees per acre varies.

in the Wallow Fire area declined; however, the number of beetles collected in traps during peak flight periods actually doubled from 2014.

In New Mexico, DFB-caused tree mortality has been decreasing for a couple of years. Declines in activity were observed in 2015 on all national forests in New Mexico, with the exception of the Gila National Forest. Activity on the Gila National Forest was observed related to the Whitewater Baldy Complex Fire that occurred in 2012. The Carson and Santa Fe National Forests, while having a reduced amount of DFB activity, still had significant activity, some of which on the Santa Fe National Forest was related to recent wildfires.

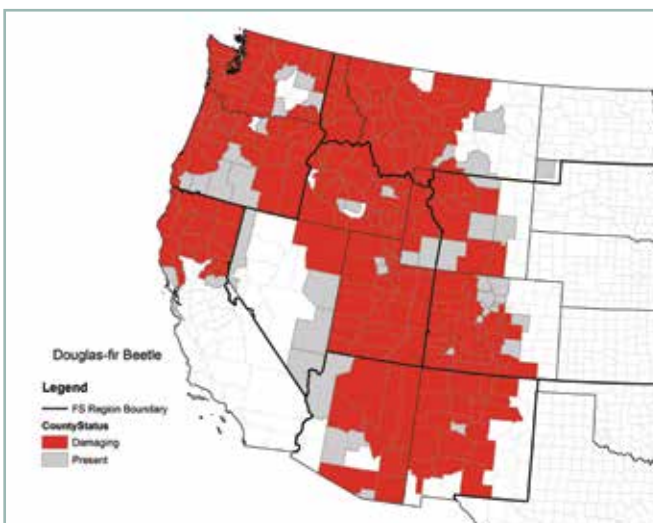


Figure 2. Douglas-fir beetle-caused mortality in 2015.

Throughout the Intermountain Region, DFB-caused tree mortality slightly increased for the second consecutive year. Within the region, some areas increased while others decreased. For instance, in Idaho, Douglas-fir tree mortality more than doubled; however, mortality remained significantly lower than the peak in 2011. Most of the 2015 tree mortality occurred on the Salmon-Challis and Sawtooth National Forests, likely a result of a combination of stressors such as fire activity over the past 5 years, drought conditions, and reduced vigor from multiple years of western spruce budworm defoliation. In Utah, Douglas-fir tree mortality decreased across all ownerships, with most mortality occurring on the Fishlake National Forest. The Fishlake National Forest has also experienced multiple years with high levels of western spruce budworm defoliation and drought conditions. In western Wyoming, DFB-caused mortality nearly doubled; however, the numbers of scattered trees recorded was less than 1,000. In Nevada, Douglas-fir tree mortality was insignificant, at less than 50 trees.

DFB-caused mortality in the Northern Rockies was detected at similar low levels in 2015 as compared to the 2014 survey and was detected on all land ownership types including Federal, State, tribal, and private lands. Tree mortality was elevated in spatially isolated pockets scattered throughout the region, typically where activity was detected the previous year. Much of the Douglas-fir host type throughout the region has experienced severe western spruce budworm defoliation for the better part of the last decade. This defoliation, if coupled with unusually warm and dry weather or another outbreak catalyst, could promote increased DFB activity in subsequent years.

DFB outbreaks in northern Idaho continued to decline within Clearwater and Idaho Counties as low levels of mortality occurred on private lands near the Dworshak Dam and reservoir near Orofino. DFB activity was not associated with western spruce budworm-caused defoliation in these locations. Substantial tree breakage and blowdown occurred during 2014–2015 winter storms across all species, including Douglas-fir, in the Nez Perce-Clearwater National Forest.

In Montana, a severe DFB outbreak continued on the Rocky Boy's Indian Reservation. This outbreak erupted in 2014 after populations amplified in host material created by a severe wind event that blew down stems infected with root and butt rot in 2011. Attacked trees in this location were not previously defoliated by western spruce budworm. Scattered DFB activity occurred in other Montana locations at low levels and was typically associated with prior western spruce budworm-caused defoliation. Notable activity occurred in the southeast portions of both the Flathead Indian Reservation and Helena National Forest. Acres of DFB-caused mortality may be underreported across the region due to difficulties associated with assessing DFB-caused mortality in trees with prior western spruce budworm defoliation.

Overall populations of DFB are high in southern Colorado, with activity ranging from the attack of individual trees, to killing entire stands in some areas (fig. 3). While DFB activity is generally dispersed, some areas of interest include the western White River National Forest, the central portion of the Gunnison National Forest, and the southwestern San Juan National Forest.



Figure 3. Mortality caused by Douglas-fir beetle near Pagosa Springs, CO.

Photo by William M. Ciesla, Forest Health Management International.

Low-level mortality of Douglas-fir resulting from DFB was observed in isolated stands in the Absaroka Mountains, Wind River Range, and Bighorn Mountains of Wyoming.

In the Pacific Northwest, areas with mortality attributed to DFB decreased in 2015 compared to 2014. In Oregon, activity was recorded in the Columbia River Gorge and Blue Mountains. In the Columbia River Gorge, DFB-caused mortality is declining. Activity in the Blue Mountains, covering the Umatilla and Wallowa-Whitman National Forests, was significant. In Washington, concentrated areas of mortality were detected in the Columbia River Gorge and in northern Kittitas and southern Chelan Counties. In central Washington, the increase in DFB is attributed to wildfires in 2012 and high levels of chronic western spruce budworm defoliation.

In California, a few small pockets of DFB-caused mortality occurred on the drier west slope of the Almanor Ranger District, Lassen National Forest (Tehama County), and along the edges of moderately burned areas of the 2014 Happy Camp Complex, Klamath National Forest (Siskiyou County).

Jeffrey Pine Beetle

Dendroctonus jeffreyi

Acres affected by Jeffrey pine beetle (JFB) were 17 times greater in 2015 than in 2014, with most of the increased mortality occurring in California. In the Intermountain Region, JFB-caused mortality remained low (fig. 4). Scattered Jeffrey pine mortality occurred on the California side of the Bridgeport Ranger District and on the Carson Ranger District of the Humboldt-Toiyabe National Forest.



Figure 4. Counties that reported Jeffrey pine beetle damage in 2015.

Groups of mortality were common in the southern Sierra Nevada range, based on aerial survey data. Scattered individual trees were attacked by JFB throughout the range of the host in locations where Jeffrey pine beetle occurs.

Western Pine Beetle

Dendroctonus brevicomis

Acres with western pine beetle (WPB) mortality doubled in 2015, with significant increases occurring in California and the Pacific Northwest (fig. 5).

In California, WPB-caused mortality in ponderosa pine in 2015 was at very high levels in the Sierra and Sequoia National Forests, Yosemite National Park, Sequoia-Kings Canyon National Park, and surrounding forested communities, with large stands of dead ponderosa pine coalescing into landscape-scale mortality. Bass Lake (Bass Lake Ranger District, Madera County), a popular recreation destination, experienced complete loss of overstory pines in several campgrounds and around lake housing communities. In Mariposa (Mariposa County) and surrounding communities, more than 50-75 percent of pines died in some areas. Several counties that include lands on the Sierra and Sequoia National Forests declared a state of emergency due to the overwhelming number of dead trees near private property, public utilities, and infrastructures. A comparison of High Sierra Ranger District, Sierra National Forest WPB plot inventories taken in 2011 and 2015 revealed that 49 percent of ponderosa pine forest stands have greater than 50 percent mortality, and mixed conifer pine forests have 17 percent mortality. Findings

estimated that about 8 million trees (greater than 15 inches in diameter at breast height [DBH]) were killed forestwide, including 51 percent of ponderosa pine and 17 percent of sugar pine. Mortality levels in the Sierra National Forest were unprecedented. Stands at elevations above 5,000 feet, where foothill vegetation transitions into mixed conifer forests, had the greatest mortality levels from Tuolumne County south to Kern County.

WPB activity increased in two separate Coulter pine plantations, as well as in scattered natural stands located on the Sawmill-Liebre Ridge of the Angeles National Forest (Los Angeles County). Ponderosa pines were killed in natural stands primarily near Sawmill Campground. Tree mortality has been persistent in this area for the past 3 years, impacting hundreds of acres of forested land.

Mortality of ponderosa pine caused by WPB continued across northern California, with some locations experiencing significant increases (Lake, Shasta, Siskiyou, and Tehama Counties).

Large increases in beetle activity were observed at lower elevations in ponderosa pine on the west slopes of the Lassen, Plumas, and Tahoe National Forests, as well as at Doublehead and Devil's Garden Ranger Districts, Modoc National Forest. WPB-related mortality was high in previous wildfire areas.

In Oregon and Washington, areas affected by WPB are represented by scattered mortality of large-diameter ponderosa pines or more concentrated damage in areas that have recently burned or are experiencing extended drought conditions. Mortality was lower than the levels recorded in 2014 in Washington and was higher than the 10-year average in Oregon. Summer drought conditions are likely an important driver of the increase, as is damage from 2012 wildfires. In Oregon, mortality was most extensive on the Malheur and Ochoco National Forests and the Warm Springs Reservation. Scattered mortality occurred from central Oregon to the southwest part of the State. In Washington, the areas with the most significant activity include the Colville and the Yakama Indian Reservation. Scattered mortality occurred in Kittitas, Ferry, Stevens, and Spokane Counties. Elevated WPB activity also occurred on both sides of the Columbia River Gorge in Klickitat, Hood River, and Wasco Counties in larger pines concurrently attacked by California five-spined ips. Although WPB is quite active in this area, it is nearly impossible to distinguish these two mortality agents during aerial surveys, and since 2010 (when the California five-spined

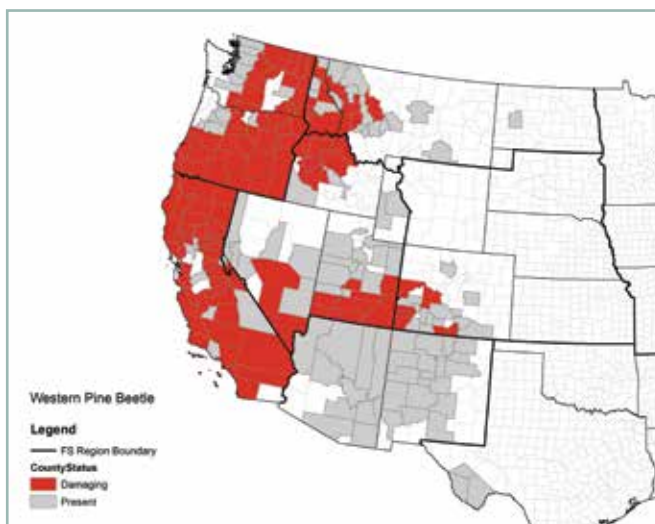


Figure 5. Counties that reported western pine beetle damage in 2015.

ips outbreak began), most ponderosa pine mortality in this vicinity has been mapped as California five-spined ips.

In the Intermountain Region, ponderosa pine mortality attributed to WPB decreased in 2015 after 2 consecutive years with increases attributed to the wildfires of 2012 and 2013. Most of the current mortality was mapped in southern Idaho on the Boise National Forest and private lands (fig. 6). In central and southern Utah, ponderosa pine mortality attributed to WPB increased. In Nevada, endemic levels of activity were reported.

Recorded acres of WPB mortality in the Northern Region decreased 87 percent between 2014 and 2015. Ponderosa pine mortality attributed to WBP declined considerably in northern Idaho counties in 2015. Tree mortality was low and scattered through most northern Idaho and western Montana counties.

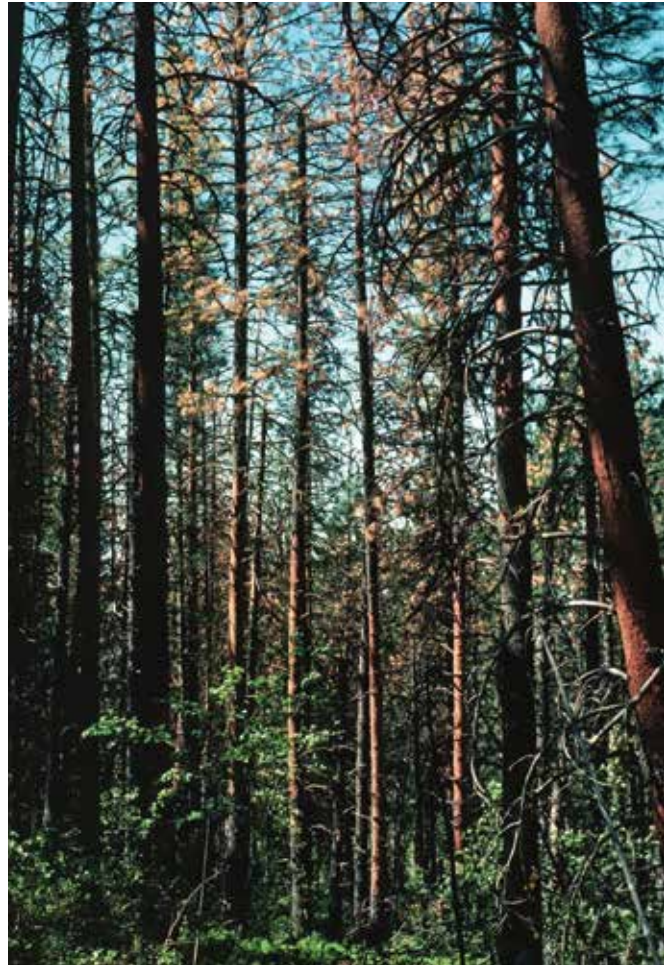


Figure 6. Western pine beetle damage on Boise National Forest, ID.

Photo by USDA Forest Service.

Western Spruce Budworm

Choristoneura freemani Razowski

Western spruce budworm (WSBW) defoliation was reported on more than 3.1 million acres in 2015 (figs. 1 and 2), a 1.5-times increase from 2014 (table 1).

Defoliation by WSBW continues to be the most widespread damage observed during aerial detection surveys in the Southwest. Most of the WSBW activity in the Southwest occurs in New Mexico, which has a greater proportion of susceptible host type. The acres mapped with defoliation in New Mexico during 2015 decreased slightly from 2014. No aerially observable damage was mapped in the southern portion of the State. The majority of WSBW-caused defoliation occurs in the forests in the northern part of the State, particularly on the Carson and Santa Fe National Forests and adjacent State and private lands. The only area in Arizona mapped with WSBW activity was on the Chuska Mountains on the Navajo Nation. Some areas such as the North Kaibab Ranger District of the Kaibab National Forest,

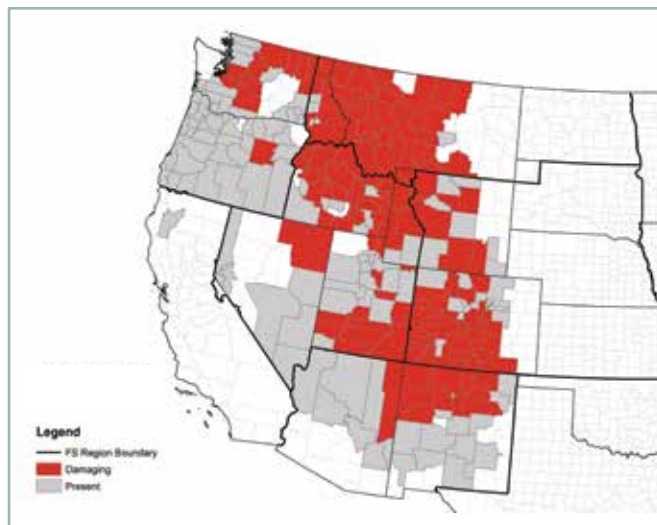


Figure 2. Western spruce budworm-caused defoliation in 2015.

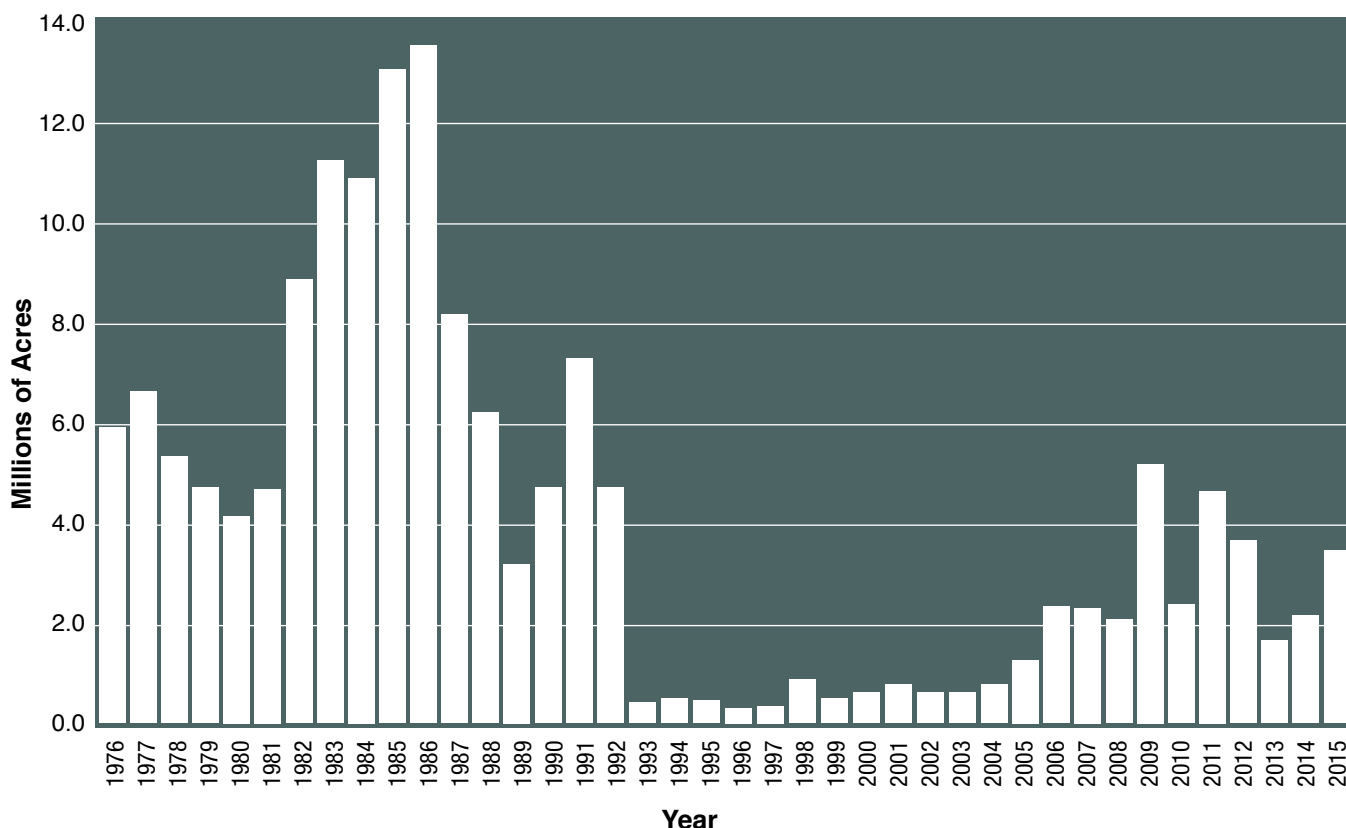


Figure 1. Counties in the contiguous United States reporting western spruce budworm defoliation in 2015.

however, have chronic budworm activity that has not been visible during aerial detection surveys.

Across the Intermountain Region, WSBW-caused tree defoliation more than doubled from 2014 to 2015, and nearly all ownerships saw an increase in defoliation. The biggest increase occurred in western Wyoming followed by southern Idaho. Populations of this insect in Idaho

have remained near outbreak levels for 11 consecutive years with 1.1 million acres defoliated. Aerial surveyors noted that new defoliation was difficult to see because of previous defoliation damage. In western Wyoming, most of the WSBW-caused tree defoliation is occurring on the Bridger-Teton National Forest. In southern Idaho, acres defoliated by budworm were at outbreak levels on the Caribou-Targhee, Boise, Payette, and Salmon-Challis

Table 1. Acres (in thousands) with western spruce budworm defoliation by State, 2002 to 2015.

| State | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|------------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Arizona | 11 | 24 | 11 | 11 | 3 | 5 | 2 | 1 | <1 | 4 | 2 | 1 | <1 | <1 |
| California | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - |
| Colorado | 131 | 20 | 20 | 71 | 94 | 390 | 153 | 382 | 213 | 90 | 217 | 156 | 178 | 313 |
| Idaho | 23 | 204 | 64 | 75 | 254 | 361 | 366 | 1,031 | 866 | 1,887 | 717 | 368 | 529 | 1,134 |
| Montana | 52 | 66 | 177 | 454 | 1,142 | 497 | 578 | 2,576 | 326 | 1,201 | 1,491 | 596 | 878 | 1,208 |
| Nevada | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| New Mexico | 199 | 143 | 238 | 184 | 143 | 452 | 360 | 559 | 317 | 501 | 477 | 298 | 303 | 242 |
| Oregon | 2 | 6 | 7 | 0 | 38 | 98 | 10 | 41 | 108 | 256 | 79 | 0 | 1 | 3 |
| Utah | 7 | 15 | 20 | 41 | 89 | 51 | 8 | 70 | 142 | 28 | 14 | 39 | 47 | 67 |
| Washington | 58 | 140 | 193 | 363 | 556 | 356 | 455 | 414 | 373 | 538 | 511 | 180 | 94 | 79 |
| Wyoming | 135 | 13 | 5 | 6 | 4 | 29 | 35 | 30 | 21 | 35 | 21 | 28 | 52 | 101 |
| Total | 617 | 631 | 735 | 1,206 | 2,322 | 2,240 | 1,967 | 5,105 | 2,367 | 4,540 | 3,529 | 1,666 | 2,082 | 3,149 |



Figure 3. Early instar western spruce budworm webbing and feeding.

Photo by Ladd Livingston, Idaho Department of Lands.

National Forests (fig. 3). Unreported subsequent Douglas-fir beetle-caused tree mortality is occurring in some heavily defoliated areas, often on the dry, south-facing sites. On all Idaho national forests, budworm is masking subalpine fir mortality caused by balsam woolly adelgid. In Utah, acres affected by WSBW defoliation increased by 30 percent from 2014, with most defoliation occurring on the Fishlake and Dixie National Forests. Defoliation was mapped in 2015 on private and Humboldt-Toiyabe National Forest lands in Nevada, where none was mapped in 2014.

In the Northern Rockies, acres defoliated by WSBW remained high and increased by approximately 25 percent. Defoliation from budworm was recorded in most counties in the western and central part of Montana in 2015. Areas with significant budworm defoliation (greater than 50,000 acres) were in the Flathead, Granite, Lewis and Clark, Meagher, Missoula, Park, and Powell Counties. This included national forest lands intermingled with surrounding lands of other ownerships. Defoliation intensity remained high in some areas, including Flathead and Missoula Counties and several counties east of the Continental Divide, where budworm has been recorded for several years. Defoliation from budworm was also recorded in most counties in northern Idaho, but defoliation intensity was generally low.

Aerially detected defoliation attributed to WSBW decreased in Oregon and Washington in 2015. In Oregon, very few areas of WSBW defoliation were detected in 2015, similar to 2014, and the lowest since 2005. The defoliation that occurred was in the Malheur National Forest near the Strawberry Mountains. In Washington, detected areas of budworm defoliation were the lowest since 2002. Mid-elevation forests in Kittitas, Okanogan, and Ferry Counties were most heavily affected. New areas of defoliation were mapped in Stevens, Pend Oreille, and Yakima Counties (fig. 4).

Heavy defoliation was observed in Douglas-fir stands along the Chief Joseph Highway (WY 296) near Hunter Peak in the Clarks Fork of the Yellowstone River, Wyoming.

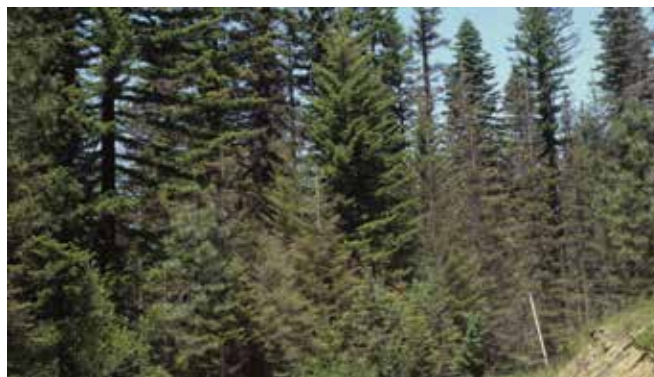


Figure 4. Western spruce budworm defoliation.

Photo by Elizabeth Willhite, USDA Forest Service.

In Colorado, multi-storied stands of Douglas-fir, white fir, and Engelmann spruce have been heavily affected by a WSBW population that rose sharply in 2015. WSBW activity was at high levels on the southern San Isabel National Forest, particularly in the northern portions of the Sangre de Cristo Mountains, the Wet Mountains, and in mixed conifer stands near La Veta. Activity was less severe on the White River National Forest, but areas with high populations included stands south of Glenwood Springs and in the Flat Top Mountains. Many portions of the San Juan National Forest have been affected, including some of the longer lasting outbreaks in southern Colorado, primarily in the eastern portions of the forest. Budworm activity has also increased in the portions of the forest near Lizardhead Pass, where budworm is also prominent just to the north on the Grand Mesa Uncompahgre and Gunnison (GMUG) National Forests. Other areas of note on the GMUG National Forests include stands to the south of the West Elk Wilderness, as well as stands to the east of Ouray. Activity has increased dramatically in the northeastern portions of the Rio Grande National Forest, just south of Poncha Pass. Notable activity was also seen further north in 2015 on the Pike National Forest in areas that overlap with Douglas-fir tussock moth outbreaks.

Hemlock Woolly Adelgid

Adelges tsugae Annand

Hemlock woolly adelgid (HWA) is reported throughout most of the Carolina and Eastern hemlock ranges across the South and into New England, with a total of 18 States and the District of Columbia reporting infestation (fig. 1). A 4.6-times increase in HWA-induced mortality occurred in 2015 compared to 2014, with nearly half of the reported damaged acres occurring in New York.

HWA is present in 13 States in the Northeastern Area. HWA has been present in Connecticut for many years and continued to cause patchy damage and decline among the remaining population of hemlocks in 2015 (fig. 2). Damage from discoloration was mapped by aerial survey in Fairfield, Hartford, Litchfield, Middlesex, New Haven, Tolland, and Windham Counties. Hemlock is native to extreme northern Delaware but is exceedingly uncommon. No surveys for HWA were carried out in 2015. Hemlock is not a significant component of Delaware's rural or urban forests. HWA has, however, been confirmed in all three counties. HWA infestation remained present in all five Rhode Island counties. Decline continued in trees previously thought not affected. No new detections occurred in Maine in 2015. Most known infestations are close to the coast or other significant water, such as in York, Cumberland, Sagadahoc,

and Lincoln Counties. No new hemlock damage or mortality was mapped in 2015.

Cold winter temperatures in 2015 again caused a significant decline of HWA populations statewide in Massachusetts. Areas that previously had large populations of adelgid are now also infested with elongated hemlock scale, which has caused a dramatic decrease in HWA populations. HWA continued to spread throughout New Hampshire and is beginning to contribute to tree mortality in areas also infested with elongate hemlock scale. No new infestations of HWA were found during town surveys but were discovered in State parks. New infestations were also reported by landowners in Bow (Merrimack County), Meredith (Belknap County), and Lee (Strafford County). Vermont reported an increase in HWA dieback and mortality, and whole stands

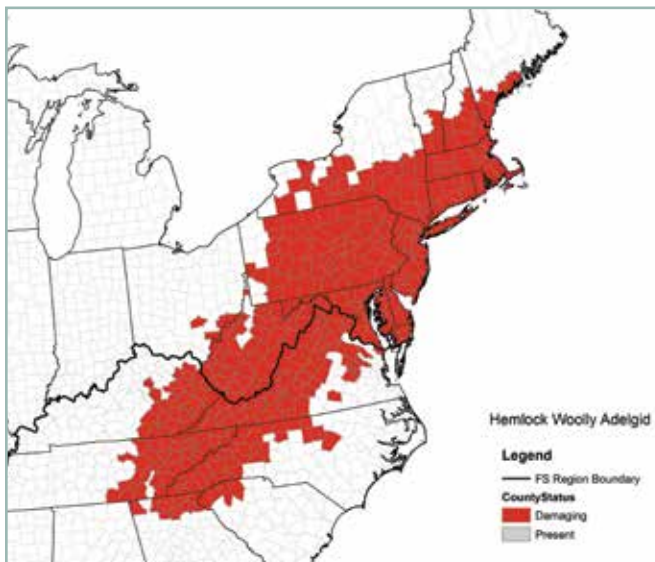


Figure 1. Counties that reported hemlock woolly adelgid damage in 2015. (Note: In the absence of a current report, a county previously listed as “damaged” remains as such.)



Figure 2. Hemlock woolly adelgid egg masses on hemlock needles.

Photo by USDA Forest Service.

were observed in significant decline. Damage was mapped by aerial survey in Windham County.

HWA occurs in the northwestern part of New Jersey, although landscape and ornamental hemlock trees are impacted throughout the State. Nearly all hemlock in New Jersey, approximately 25,000 acres, has been infested with HWA to some extent. There were no new counties found to be infested by HWA in New York in 2015, although its range within the counties already infested appeared to increase slightly. HWA continued to cause damage and mortality to native forest and ornamental eastern hemlock trees. Damage was most severe in areas that have been infested for several years (the Catskills and South), although damage in the Finger Lakes region is beginning to catch up in severity. In some areas, a majority of the trees are infested, and many of those are in declining health or dead. Damage was mapped by aerial survey in Delaware, Dutchess, Greene, Orange, Putnam, Sullivan, and Ulster Counties.

In Pennsylvania, HWA leading-edge surveys were continued in 17 counties in 2015. One additional county (Armstrong) was added to the infestation list. Infestation has been found in 59 of 67 counties.

Significant hemlock decline in Virginia continues in many areas due to HWA. The adelgid continues to spread and

is currently found throughout the entire range of eastern hemlock within Virginia, aside from several pockets. Sites surveyed in western and southwestern Virginia in 2015 showed mean percent mortality of hemlock of 30 percent, a 3 percent increase from 2014. As percent mortality continues to increase, stand health index is decreasing. However, the percentage of infested branches in 2015 is the lowest it has been in the previous 18 years. This could be the result of recent cold winters and multiple cycles of the “polar vortex” causing short-term crashes in adelgid populations. HWA is present statewide in Maryland. Increasing populations, especially in the western part of the State (Garrett County), were detected in 2015.

HWA is found in 33 Kentucky counties; Magoffin, Pulaski and Wayne Counties were added in 2015. Since its discovery in 2006, HWA has spread throughout the majority of the eastern hemlock’s range in Kentucky (fig. 3). Hemlocks are being chemically treated in many areas, but an accurate estimation of hemlock mortality outside of treated areas is not known. Future surveys are planned to gather more information.

No new infested counties were reported in Virginia, Tennessee, North Carolina, South Carolina, or Georgia in 2015.



Figure 3. Hemlock mortality caused by hemlock wooly adelgid in the Great Smoky Mountains. Photo by Ignazio Graziosi, University of Kentucky.

Laurel Wilt Disease/Redbay Ambrosia Beetle

Raffaelea lauricola T.C. Harr., Fraedrich, and Aghayeva
Xyleborus glabratus Eichhoff

The spread of Laurel Wilt (LW) disease, transmitted by the non-native ambrosia beetle *Xyleborus glabratus*, throughout the Southeastern United States, has been charted county-by-county since 2005. As of September 2015, the presence of LW had been confirmed in a total of 44 counties in Georgia, mostly in redbay trees, but many detections were from sassafras trees in the absence of known redbay populations (fig. 1). Detections in sassafras in the southwestern corner of Georgia (Decatur and Seminole Counties) are likely a result of spread from an expanding disease episode in the panhandle of Florida. Since its arrival in Florida was confirmed in 2005, LW has spread rapidly through most of the State (fig. 2). It is currently causing heavy losses of swamp bay in sensitive tree islands in the Everglades, and impacting commercial avocado groves in Miami-Dade County. From November 2014 to October 2015, new records of LW were confirmed in Gadsden, Holmes, and Jackson Counties, affecting redbay, swamp bay, and sassafras.

In South Carolina, redbays continue to die as a result of infection by this fungus (fig. 3). In 2015, infection was reported from Richland County, a new record for the State. Ground surveys in North Carolina confirmed that LW is present in Duplin County in 2015 and was also found in additional areas within the previously affected counties.

Alabama reported no new counties in 2015. Mortality of redbay, swampbay, camphor, and sassafras continues in

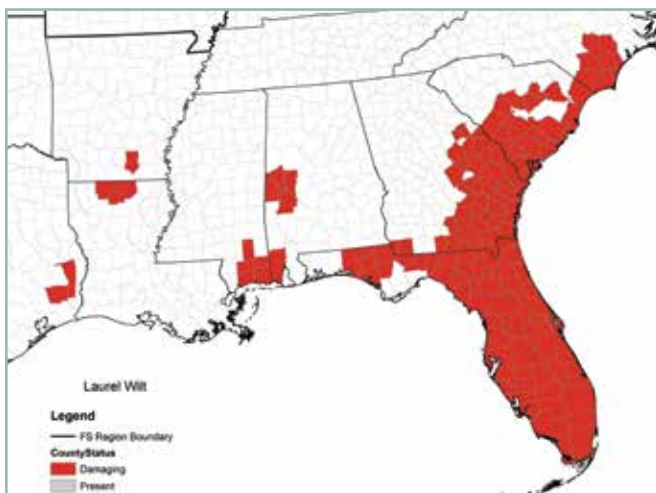


Figure 1. Counties with detected laurel wilt disease damage in 2015.

Jackson County, MS. Mortality is severe, especially in and around the Pascagoula River Basin. LW range continues to expand northward and is nearing the northern boundary of the coastal plain and range of redbay/swampbay. Stone and Perry Counties were newly confirmed in 2015. LW was detected for the first time in Hardin and Jasper Counties, TX, and Bradley County, AR, in 2015.



Figure 2. Redbay mortality caused by redbay ambrosia beetle and associated fungus, laurel wilt disease, in Florida.

Photo by Albert (Bud) Mayfield, USDA Forest Service.



Figure 3. Vascular staining caused by the laurel wilt fungus.

Photo by Albert (Bud) Mayfield, USDA Forest Service.

Spruce Budworm

Choristoneura fumiferana Clemens

Throughout the Northeastern Area, acres showing defoliation damage from spruce budworm (SBW) more than doubled from 2014 to 2015, with large increases seen in both Wisconsin and Michigan (fig. 1).

SBW populations increased in Michigan for the third consecutive year. Heavy defoliation was observed in both the eastern and western ends of the Upper Peninsula. Historically, populations can remain high for several years before collapsing. On the Ottawa National Forest, SBW defoliation damage has been reported for the past 6–7 years, and mortality to spruce and balsam fir has become significant. Some pockets of SBW-caused defoliation were reported within the southwest quarter of the Hiawatha National Forest (HNF) in

2015. On the western side of the HNF, much of the balsam and spruce has been defoliated over the past 5–6 years and has now died. Defoliation was observed along the eastern and northern portions of the eastern side of HNF. There was also SBW defoliation and mortality in the southeast part of HNF (northwest of the city of St. Ignace).

Damage has been detected and mapped in portions of northern Wisconsin for the past 6 years, and the number of acres with defoliation damage increased significantly in 2015 (fig. 2).

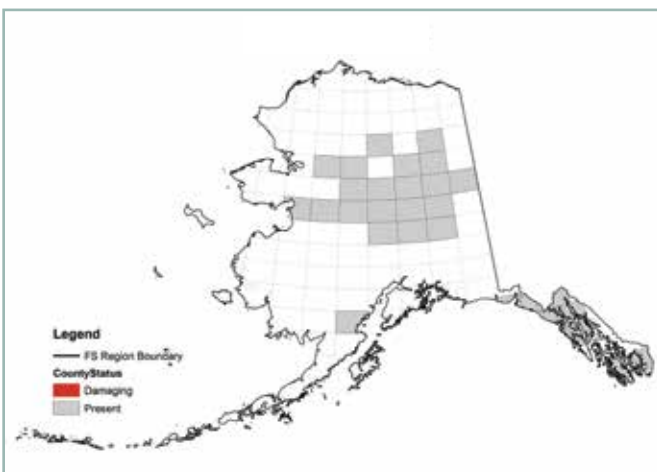
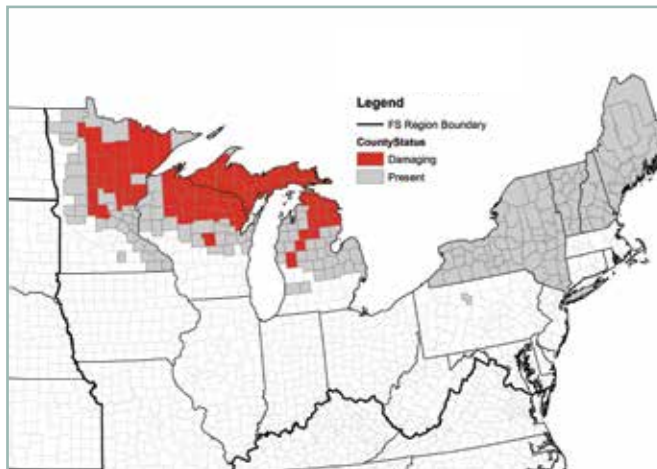


Figure 1. Counties that reported spruce budworm damage in 2015.



Figure 2. White spruce mortality on the Chequamegon National Forest, WI, as a result of spruce budworm, drought, and root disease.

Photo by Steven Katovich, USDA Forest Service.

The last SBW outbreak in Wisconsin was from 1970 to 1980, and regional outbreaks typically occur every 30-50 years. On the Chequamegon-Nicolet National Forest, SBW defoliation damage increased in 2015. On the Nicolet side, defoliation and mortality were mapped along the Michigan border in areas with a history of SBW. Further south on the Laona District, defoliation damage (no mortality) was observed. On the Chequamegon side there was defoliation (no mortality) within the Parks Falls and Hayward Districts.

In 2015, the defoliation acreage increased by 10 percent from the previous year in Minnesota. About 95 percent of the 2015 defoliation occurred in Lake and St. Louis Counties. Mortality was noted on 45 percent of the impacted acreage in 2015. On the Superior National Forest, significant SBW defoliation was observed, and it seems to be moving south and east from where it had been mapped in past years (fig. 3).

No SBW damage was detected in either ground or aerial surveys in Maine, and no damage was reported in Vermont in 2015. No significant defoliation by the insect was detected in 2015 in New York.



Figure 3. Spruce budworm needle damage.
Photo by Joseph O'Brien, USDA Forest Service.

Sirex Woodwasp

Sirex noctilio Fabricius

No new infested counties were detected in New York in 2015, although it is assumed that most of the State is likely infested (fig. 1). Within the known infestation, much of the worst damage was found on State-owned pine plantations, many of which are overstocked and/or in declining health. In Pennsylvania, Lackawanna County was added to the

infestation list in 2015 (fig. 2). As of October 2015, 16 out of 67 Pennsylvania counties were infested with Sirex, all in the northern part of the State. Surveys in Delaware, Maryland, and New Jersey did not detect Sirex or any signs of infestations.



Figure 1. Resin beads, characteristic of sirex woodwasp attack on scots pine, New York.
Photo by Kevin Dodds, USDA Forest Service.



Figure 2. Female adult sirex woodwasp.
Photo by David R. Lance, USDA Animal and Plant Health Inspection Service, Plant Protection and Quarantine.

Asian Longhorned Beetle

Anoplophora glabripennis Motschulsky

By the end of 2015, Asian longhorned beetle (ALB) infestations continued to be found in Massachusetts, New York, and Ohio (fig. 1).

As of November 2015, there were 24,399 trees that have been identified as infested in the 110-square-mile quarantine area in Worcester, MA. One female ALB adult was detected with traps on August 14, 2015, on Lincoln Street in Worcester. No additional adult beetles were found by trapping. As of March 2014, the ALB infestation in the Jamaica Plain suburb of Boston was declared eradicated, and no other infested trees have been found or reported in the Boston area.

ALB was not detected in any new counties in New York in 2015. Cooperative efforts to eradicate ALB from the quarantined areas in New York City and Long Island are ongoing (fig. 2). Trapping continued at Department of Environmental Conservation campgrounds identified as high risk, but no new infestations were found.

ALB surveys and removal efforts continued this year in Clermont County, OH (fig. 3). As of November 7, 2015, the program had discovered 17,502 infested trees of the 1,643,729 trees surveyed. Surveys continue to delimit the affected area.

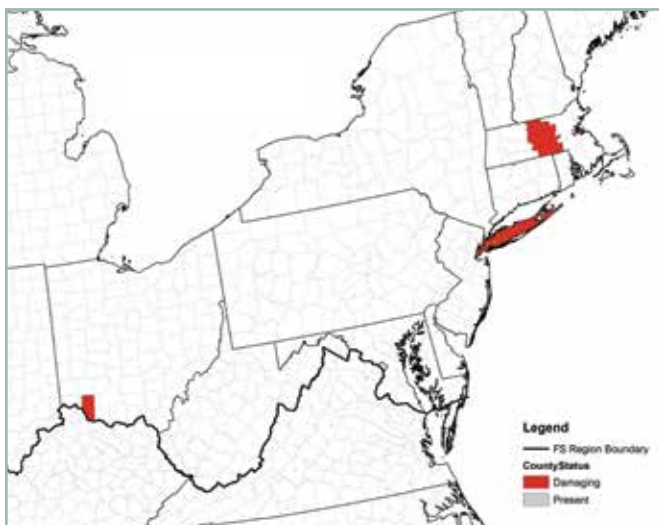


Figure 1. Counties that reported Asian longhorned beetle in 2015.



Figure 2. Asian longhorned beetle damage seen in urban area.

Photo by Thomas B. Denholm, New Jersey Department of Agriculture.



Figure 3. Assorted Asian longhorned beetle larval sizes removed from infested tree.

Photo by Steven Katovich, USDA Forest Service.

White Pine Blister Rust

Cronartium ribicola J.C. Fisch. ex Rabenh

Since the introduction of *Cronartium ribicola* into North America over a century ago, white pine blister rust (WPBR) has spread throughout the range of most western five-needle pines in the Intermountain West (fig. 1).

In the Northeastern Area, there were no new reports of WPBR in New Jersey, Ohio, West Virginia, Pennsylvania, or Maryland in 2015. WPBR continues to be found throughout New Hampshire and New York, though no significant damage was reported in 2015. In 2015, WPBR-caused mortality was mapped by aerial survey in Franklin, Orange, Orleans, Washington, Windham, and Windsor Counties in Vermont (fig. 2).

Although WPBR flare-ups are known to occur from time to time on Christmas tree farms in West Virginia, and the State quarantine is in effect for several counties, no new detections were reported in 2015.

In the Northern Region, high incidences of WPBR occur on western white pine, whitebark pine, and limber pine. WPBR has spread throughout the range of western white pine in the inland Northwest. Although western white pine can still be found at low densities on much of its original range, acres where western white pine still dominates have shrunk



Figure 2. Small branch infestation on eastern white pine.

Photo by Joseph O'Brien, USDA Forest Service.

dramatically, to around 5 percent of historic range. No new detections were reported for the Northern Region in 2015

In Arizona and New Mexico, WPBR causes widespread mortality on five-needle pines. Southwestern white pine is the primary host 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. No new reports for WPBR were reported in 2015.

Across the range of the Rocky Mountains, WPBR is most frequently found on whitebark and limber pines. Plots have been established in the Intermountain Region to survey spread and intensity of the disease on limber, whitebark, Great Basin bristlecone, and western white pine. In Utah, the pathogenic fungus has not yet been detected on pine hosts. WPBR is known to occur in northern Idaho, western Montana, and parts of Wyoming and Colorado (fig. 3). Surveys conducted on limber pine in Custer State Park, SD, revealed no new infections in 2015.

In the West, WPBR occurs over much of its range in California and remains a problem throughout the Sierra Nevada, affecting sugar pines and other five-needle pines. There are no new locations reporting WPBR for 2015, so the

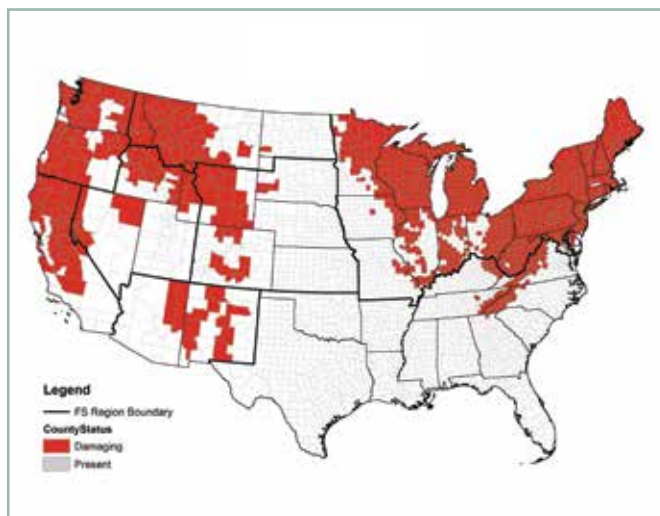


Figure 1. Counties where white pine blister rust damage was detected in 2015. (Note: In the absence of a current report, a county previously listed as “damaged” remains as such.)

range of this pathogen continues to be all forests where there are five-needle pine populations from the Southern Sierra Nevada Mountains up to the Oregon Border. However, there

are some very high elevation and eastern California five-needle pine stands that appear unaffected by the disease.



Figure 3. Limber pine killed by white pine blister rust in Wyoming.
Photo by Bruce Moltzan, USDA Forest Service.

Oak Wilt

Ceratocystis fagacearum Bretz

Oak wilt (OW) disease conditions in almost all Southern Region States have been static for a number of years with no new positive counties being recorded (fig. 1). Surveys for OW are no longer routinely performed in most States, and serious or widespread damage is generally unknown except in Texas, where widespread mortality of live oak and Texas red oak continues. Texas Forest Service annually supports a suppression program to minimize the spread of the disease. No new detections were reported for the Southeastern States in 2015.

OW is known throughout the Northeastern Area (fig. 2). New York had no new occurrences of OW outside of Schenectady County. Monitoring in the area is ongoing, and aerial surveys have shown no further infection centers. Minnesota recorded new finds in Morrison and Mower Counties in 2015. No new counties were reported for Iowa, Illinois, Indiana, Michigan, Missouri, or Wisconsin, even though distribution of OW is known throughout these States.

Positive OW finds were recorded in the Snaggy Mountain area of the Potomac/Garrett State Forest in Maryland. West Virginia reported finds in 52 of 54 counties sampled, and Pennsylvania confirmed OW in Tioga in September 2015 (fig. 3). The Ohio State University diagnostics laboratory confirmed OW in Summit, Franklin, and Lucas Counties.

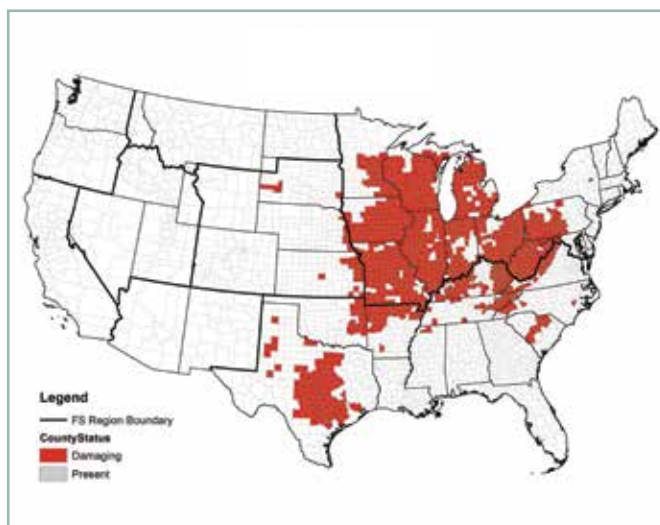


Figure 1. Counties that reported oak wilt damage in 2015. (Note: In the absence of a current report, a county previously listed as “damaged” remains as such.)



Figure 2. Oak wilt-caused mortality on northern pin oak in Ramsey County, MN.

Photo by Steven Katovich, USDA Forest Service.



Figure 3. Oak wilt leaf symptoms.

Photo by Joseph O'Brien, USDA Forest Service.

Dogwood Anthracnose

Discula destructiva Redlin

Cornus florida (flowering dogwood) is widely distributed across the eastern landscape of the United States and is one of the most common understory trees in North America. Dogwood anthracnose (DA), caused by the fungus *Discula destructiva*, has been identified as the cause of *C. florida* mortality throughout the East, particularly in the Appalachian ecoregion (fig. 1).

In the Northeastern Area, DA continued to affect flowering dogwood throughout its range across the New England region, but there was no significant activity reported in 2015. In New York, DA continued to affect understory and ornamental flowering dogwood across the State, although very little damage was observed in 2015, and the disease was not reported in any new areas.

Although few reports were given, DA is expected to be common and widespread in forested areas throughout Pennsylvania, New Jersey, Maryland, District of Columbia, West Virginia, and Ohio (fig. 2). In contrast to some other areas in the Mid-Atlantic region, Delaware has many healthy dogwood trees. Dogwood anthracnose is present in Delaware, but many specimens appear to tolerate it or have escaped infection entirely.

No surveys for this disease were carried out in 2015. Additionally, no reports were given for New Jersey, District of Columbia, Pennsylvania, Ohio, Maryland, West Virginia, or the Southern Region. The rate of mortality has increased in the past 10 years, compared to the previous decade.

With nearly 2 billion trees dying per decade, the rate and scale of mortality from DA is akin to other North American forest pandemics, including chestnut blight and Dutch elm disease (http://www.srs.fs.fed.us/pubs/gtr/gtr_srs167/gtr_srs167_191.pdf).



Figure 2. Lower branch dieback.

Photo by Charles Hoysa, Virginia Cooperative Extension, <http://Bugwood.org>.



Figure 1. Dogwood anthracnose leaf symptoms.

Photo by Robert L. Anderson, USDA Forest Service.

Beech Bark Disease

Cryptococcus fagisuga Lindinger
Neonectria ditissima Tul. & C. Tul. Samuels & Rossman
N. faginata Lohman

Beech bark disease (BBD) continues to be found in the Northeast and South as far west as Wisconsin, as far south as central Virginia, and in isolated locations in eastern Tennessee and western North Carolina (fig. 1). In 2015, surveys detected BBD mortality on approximately 182,000 acres, a nearly 2.5-times increase from 2014.

There was widespread mortality of American beech in 2015 in the western part of North Carolina, where elevation exceeded 3,500 feet. The highest mortality was reported in Avery and Mitchell Counties. In Virginia, the known distribution of the BBD complex has expanded in 5 additional counties (Grayson, Green, Page, Rappahannock, and Rockingham), bringing the total number of counties to 11 (including Albemarle, Bath, Highland, Madison, Nelson, and Rockbridge Counties). Most BBD detections are isolated and not more than 1/4 to 1/2 acre in size (fig. 2). These tend to be at elevations between 2,000 and 4,000 feet, and the disease complex is not currently detected below 1,500 feet in Virginia.

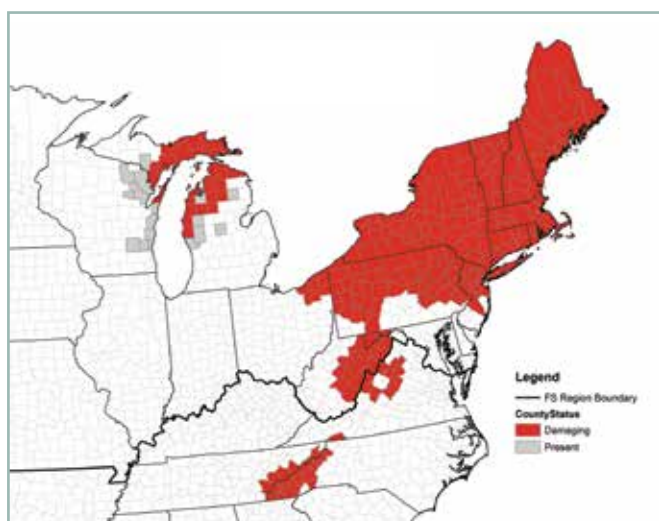


Figure 1. Beech bark disease-induced mortality in 2015. (Note: In the absence of a current report, a county previously listed as “damaged” remains as such. In Michigan and Wisconsin, counties in gray indicate the advancing front of the disease with the presence of the scale, and counties in red indicate the detection of tree mortality.)

In the Northeast, there was no significant BBD activity reported in Massachusetts or Connecticut in 2015. Crown dieback and mortality of beech was mapped by aerial survey in 2015 in all counties throughout Vermont. The disease remained common throughout beech stands in New Hampshire, and infestation of beech continued throughout most of Rhode Island in a very limited number of trees, with few beech showing signs of the disease. In Delaware, ongoing surveys for BBD assessed more than 100 trees at 4 sites in New Castle and Kent Counties for scale and dieback. No scale was detected, and BBD is likely not established; surveys are ongoing. No significant activity was reported in Maine. Surveys in Maryland newly detected BBD in Garrett County in 2015.

Mortality was mapped by aerial survey in Sullivan County, NY, though no acres were reported in 2015. In New Jersey, BBD was mainly found in the northwestern portion of the State. Although beech is found in pockets statewide, the disease has not been detected in any central or southern counties. In 2015, the New Jersey State Forest Service, in conjunction with the USDA Forest Service, monitored beech stands across the State. The majority of beech found in the northern counties have been infested and infected



Figure 2. Tarry spots and beech scale on American beech.

Photo by Joseph O'Brien, USDA Forest Service.

by both the scale and fungus, respectively. Further, scale has not yet been identified in the southern half of the State, though some small-scale populations have been identified in the central counties.

Reports of BBD have been confirmed in northeast Ohio for several years at Holden Arboretum, and re-sampling this year revealed that the amount of beech scale encountered is much reduced from recent years. In Pennsylvania, a total of about 1,792 acres of damage attributed to BBD were mapped by aerial surveys in 2015. Door County in Wisconsin continues to be the only county where both the beech scale and the *Neonectria* fungus have been found to be present and associated with tree damage (fig. 3). Mortality is still limited to the initially detected area in Door County, but dieback is now found at several other sites in Door County.



Figure 3. Beech snap in a stand infected with beech bark disease.

Photo by Joseph O'Brien, USDA Forest Service.

Pests To Watch

Root Diseases

Numerous species

Root diseases are typically widespread and have greater long-term impacts on forest composition, structure, and function than insect outbreaks. Unlike many insect outbreaks that may kill most trees in discrete pockets quickly, root diseases suspected in an area are difficult to confirm due to their sporadic disease signatures and their location within the root system. They are also underestimated in aerial detection surveys, which tend to focus on insects. Tree canopies thin slowly before death, and mortality from root disease is often followed by beetle infestation. More than one root disease agent can contribute to mortality. *Armillaria* root disease, laminated root rot, *Heterobasidion* root disease, and Schweinitzii root and

butt rot often co-occur in different combinations in the same stand and even in the same root system. Two of these diseases are discussed in the following sections.

Armillaria Root Disease

Armillaria spp.

Armillaria root disease (ARD), caused by fungi in the genus *Armillaria*, has worldwide distribution, affecting many tree species and causing major damage throughout North America (fig. 1). Ecological evaluations on ARD are important to assess forest management needs in the future and to best represent the risk to the forest resource

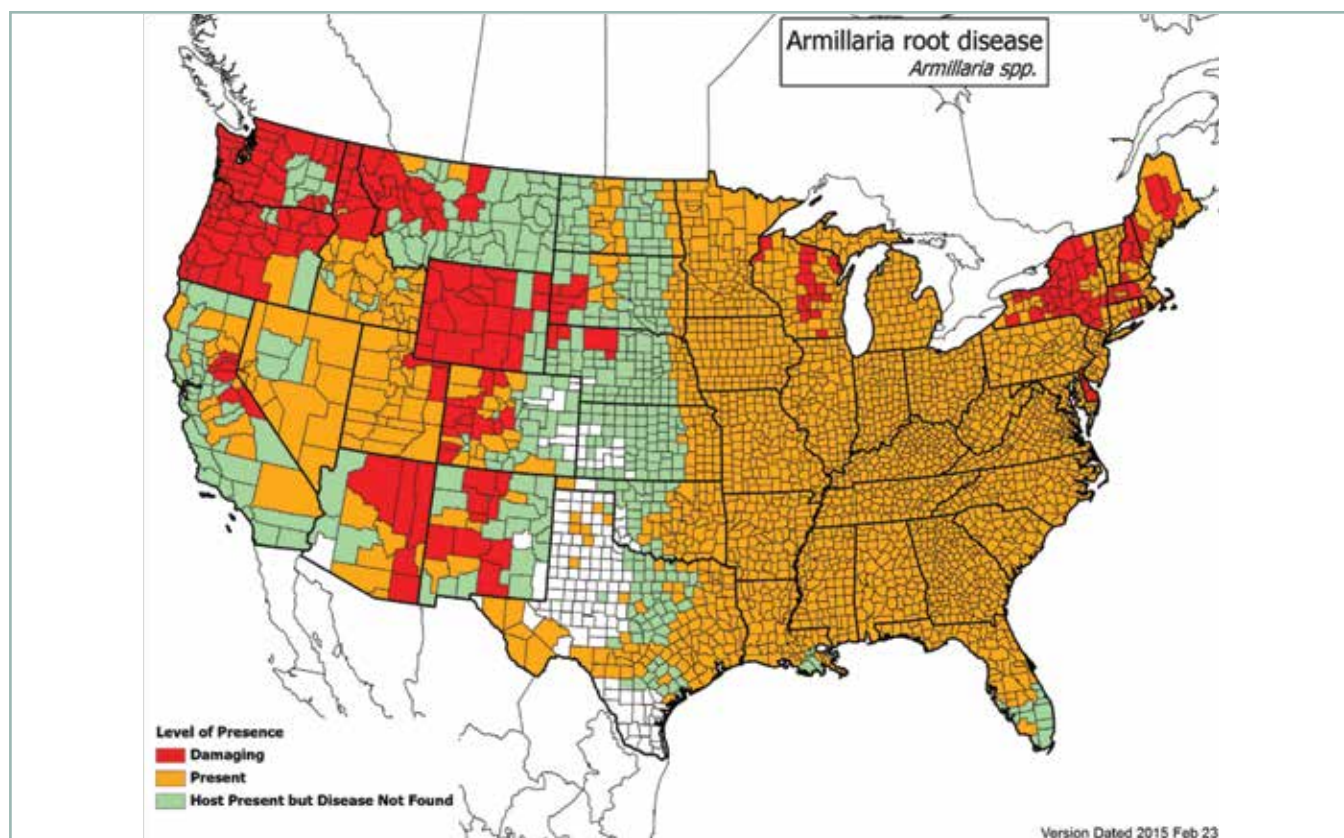


Figure 1. Distribution of hosts and damage caused by *Armillaria* root disease (from Lockman, I.B.; Kearns, H.S.J., eds. 2016. Forest root diseases across the United States. Gen. Tech. Rep. RMRS-GTR-342. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 55 p., <http://www.treesearch.fs.fed.us/pubs/50767>).

in national insect and disease risk maps. The following summarizes stand-level impacts reported for survey efforts in 2015.

In the North Central States of Iowa, Illinois, Indiana, Michigan, Minnesota, Missouri, and Wisconsin, no annual surveys were conducted to detect ARD by county; it is known to occur statewide on hardwoods and conifers that are predisposed by various stress factors. It is considered ubiquitous and occurs commonly in combination with drought, defoliation, and other abiotic stressors. In 2015, areas of specific ARD were mapped in Adams, Jefferson, Marathon, Sauk, and Waukesha Counties in Wisconsin and in Pine County in Minnesota. No cumulative acres were reported.

In the Northeast, no ARD detections occurred in either Maine or Massachusetts in 2015. Although known statewide in Vermont, no damage attributed to ARD was reported in 2015. Paper birch mortality and damage attributed to

ARD and ice storms were aerially surveyed in Cheshire and Merrimack Counties in New Hampshire in 2015. ARD is present in all New York counties, though not listed as a primary damage agent; instead, it is associated as a contributing factor in “decline” situations. ARD is present statewide in Delaware.

In the Northern Region, ARD is the most common and damaging root pathogen in northern Idaho and western Montana. This disease can impact all conifer species at a young age but is the main cause of death and growth loss of Douglas-fir and true firs of all sizes. Forest Inventory and Analysis plots show that more than 5.6 million acres of national forest lands in north Idaho and western Montana have some level of ARD or a combination of one or more root diseases. Damage is most severe on the best growing sites. Severely impacted areas are converted to brush and have little likelihood of recovering without intervention. Despite this lack of reporting, root diseases such as ARD are typically more widespread now than they were and are having greater long-term impacts on forest composition, structure, and function.

In the Rocky and Intermountain Regions, ARD was reported in Colorado, Wyoming, South Dakota, and Nebraska (fig. 2). A study in Colorado recently confirmed a first report of *Armillaria solidipes* (as *A. ostoyae*) causing ARD in Boulder County (subalpine fir, Douglas-fir), Pueblo County (Douglas-fir), Huerfano County (Engelmann spruce), and Larimer County (lodgepole pine). All four of these *Armillaria* species were causing root disease in scattered stands, largely in riparian areas.



Figure 2. Symptoms of *Armillaria* root disease in a ponderosa pine stand.
Photo by USDA Forest Service.



Figure 3. *Armillaria* root disease in white spruce.
Photo by Joseph O'Brien, USDA Forest Service.

No new reports of ARD mortality were recorded in the Southwestern or Pacific Northwest Regions in 2015.

In south-central and southeastern Alaska, ARD has been mapped on paper birch and white spruce in several locations (fig. 3). In southeast Alaska, ARD species are common on all tree species but are generally not considered destructive—merely associated with the death of stressed trees. However, aggressive disease behavior has recently been observed in a young-growth yellow-cedar stand, with yellow-cedar decline symptoms observed on Kupreanof Island. Researchers from the Rocky Mountain Research Station have identified ARD collected from yellow-cedar in this stand and from western hemlock trees near Juneau as *Armillaria sinapina*. Collections made from hardwood and conifer hosts from the Kenai Peninsula to the Arctic Circle in 2007 were all also identified as *A. sinapina*.

Heterobasidion Root Disease

Heterobasidion spp.

Heterobasidion is an economically important genus that is widespread in the Northern Hemisphere and occurs on at least 200 different species in 31 genera of conifers and hardwoods. Two groups considered important in the United States are classified as P-type (*Heterobasidion irregulare*) and S-type (*Heterobasidion occidentale*) (fig. 4).

As a disease-causing agent, the full ecological effects of *Heterobasidion* root disease (HRD) have not been fully evaluated over long temporal and spatial scales. However, killing planted or naturally regenerated seedlings and saplings, and persistent in heavily infected fir stands, the disease can cause serious but unquantified impacts. HRD functions as a saprophyte, playing a vital role in recycling dead trees, stumps, and roots.

In the Northeastern Area, HRD is present in Illinois, Indiana, Iowa, Maine, Michigan, Minnesota, Missouri, Vermont, and Wisconsin (fig. 5). In Illinois, HRD has been confirmed in 11 counties, with records going back to 1964. Since 1971, there is no record of further *H. annosum* surveys. No new county records were added for Indiana in 2015. Fruiting bodies have been observed at soil line on stumps and live white pine in thinned plantation in Monroe County. Fruiting bodies are also present on pine bolts left in the thinned plantation. Observed fruiting bodies on white pine stumps in Jackson County (Jackson-Washington State Forest) and on Virginia pine wind throw in Clark County (private land) have led forest health professionals to conclude white pine is more susceptible to *H. annosum* than red pine. HRD is known to

occur throughout Iowa on pines or red cedar. Historically it has been reported on jack pine in Stephens State Forest and white pine in Shimek and Yellow River State Forests. There were no new county records in Iowa in 2015.

HRD was first confirmed in Minnesota in 2014 in Winona County, using polymerase chain reaction (PCR) testing and DNA sequencing. In 2015, the Minnesota Department of Natural Resources, University of Minnesota, and the University of Wisconsin surveyed extensively within Minnesota using three techniques, and no new county records were found. Damage is scattered within the counties where HRD infestation has been recorded in Wisconsin. While HRD has been found on individual white spruce trees in the past, 2015 marks the first year it was found causing pockets of mortality in spruce plantations. HRD may not be native to Wisconsin and was first found in 1993. It is causing concern due to uncertainty of how long it will prevent growing pines once land is infested and how best to balance preventing the disease with the cost of treatment. Wisconsin requires use of specified precautions against HRD on State-owned lands that are within 25 miles of a known HRD location.

Michigan recorded new records in 2015 in Barry, Grand Traverse, Kalkaska, Mecosta, and Newaygo Counties. Efforts to survey and delimit the distribution of HRD in Michigan are ongoing.

New county records in Missouri added in 2015 included Crawford, Ozark, Phelps, and Pulaski Counties. In 2014, University of Missouri researchers conducted ground surveys and placed spore traps. The following counties had evidence of limited wind throw or dead trees with fruiting bodies: Crawford, Dent, Douglas, Phelps, Pulaski, and Ozark. In Shannon County, fruiting bodies were found associated with pine stumps. Positive spore traps were found in Butler and Washington Counties, where HRD had been confirmed present in Clark National Forest in 1965. HRD conks were reported on eastern red cedar in Boone and Wayne Counties in 2009. HRD was reported earlier on shortleaf pine in Carter, Iron, Reynolds, and Shannon Counties.

In western Montana, HRD affects ponderosa pine of all ages. Most damage is concentrated in lower elevations, where ponderosa pine is the dominant tree species, and past harvesting of large trees has been common. Presence of HRD in ponderosa pine stands greatly decreases the potential for managing ponderosa pine. These sites are usually too dry to effectively grow alternative tree species, so preventing the introduction and subsequent increase of

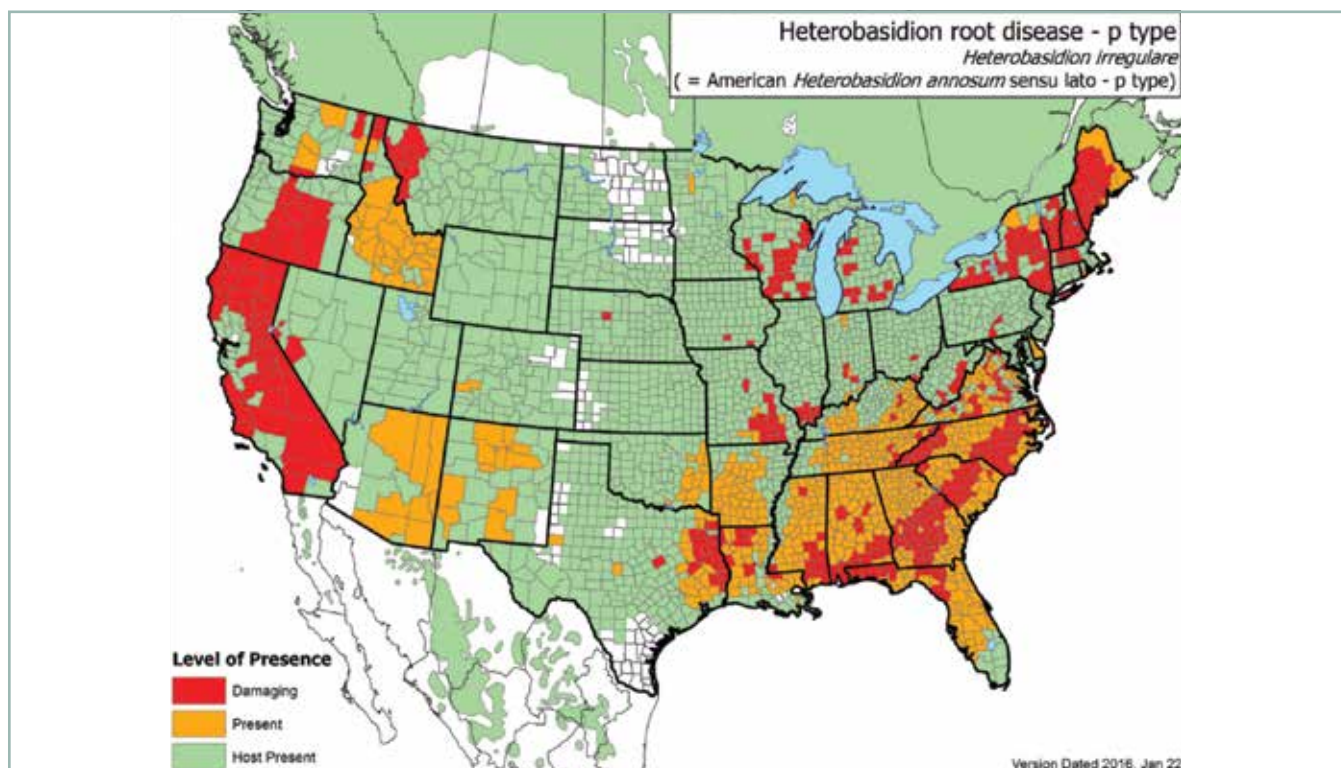
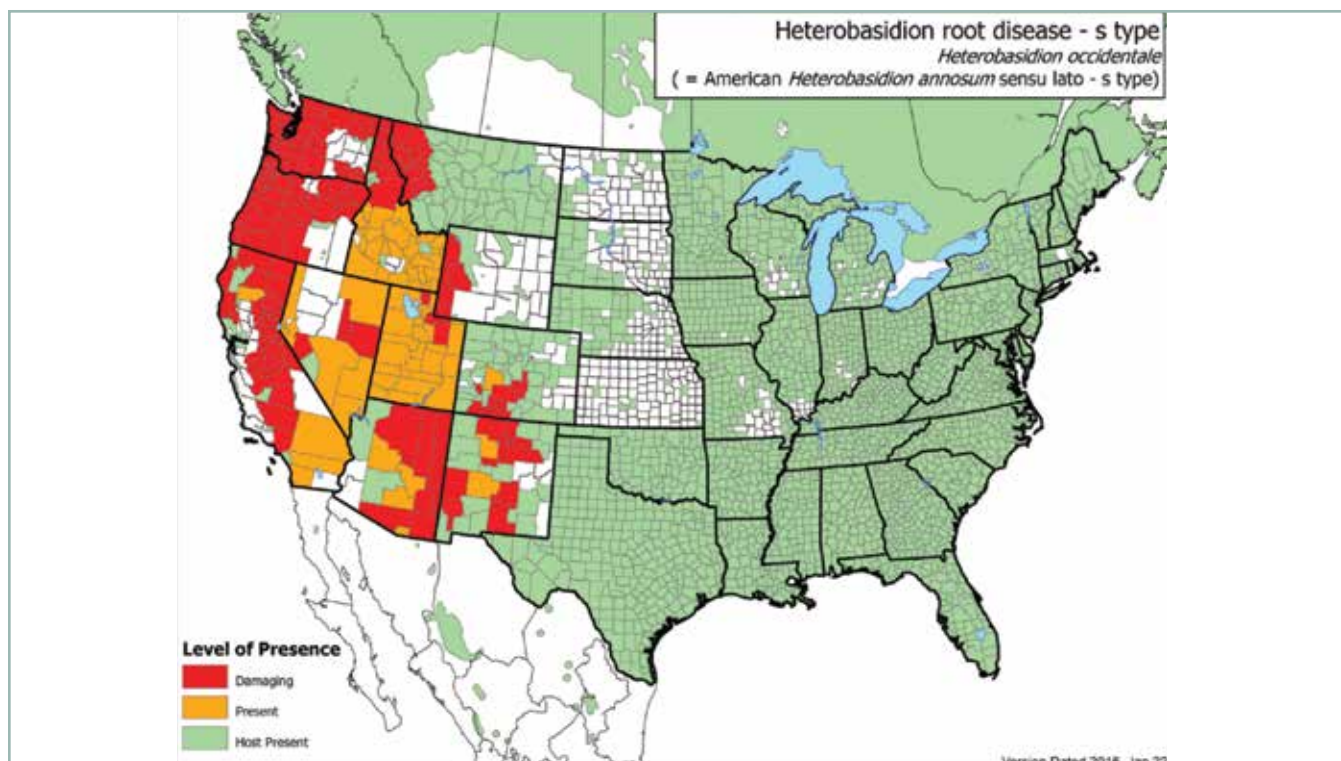


Figure 4. Distribution of hosts and damage caused by both S- and P-type *Heterobasidion* root disease (from Lockman, I.B.; Kearns, H.S.J., eds. 2016. Forest root diseases across the United States. Gen. Tech. Rep. RMRS-GTR-342. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 55 p., <http://www.treesearch.fs.fed.us/pubs/50767>).

HRD is crucial for managing ponderosa pine.

In Montana, just over 114,000 total acres are estimated to be impacted, calculated from a survey done in 2003 and 2004 and permanent plots established in 1994. Actual acres impacted in northern Idaho are not known.

HRD occurs in small pockets throughout the Intermountain Region, infecting piñon pine true fir, spruce, and Douglas-fir. HRD caused by *Heterobasidion irregulare* is of limited occurrence. It can be found killing small pockets of pinyon pine in a few counties in Colorado, Utah, and Nevada, as well as in limited areas along the California/Nevada border impacting Jeffrey and ponderosa pine on the Bridgeport Ranger District of the Humboldt-Toiyabe National Forest (fig. 6). No new reports were recorded in the Intermountain Region in 2015.

In Nebraska, *Heterobasidion* P-type was identified from the Bessey Ranger District, Nebraska National Forest.

In the Southwestern Region, HRD S-type is broadly distributed in the wet mixed coniferous forests of Arizona and New Mexico. Fruiting bodies are commonly found inside stumps or on the roots of downed logs. HRD P-type is not considered to have a major impact on ponderosa pine in either Arizona or New Mexico, where it occurs in widely distributed but localized populations, typically on limestone soils, throughout the region. No new reports from surveys were recorded in 2015.

In 2015, aerial surveys mapped acres of blowdown estimated at more than 70,000 trees following a severe

windstorm in Lassen Volcanic National Park and Eagle Lake on the Lassen National Forest in California. Roots of some of the blowdown trees were assessed for decay caused by both HRD P-type and S-type in Ashpan Snowmobile Park. Ponderosa pine had HRD near the western extent of the blowdown in Hat Creek Campground and south of Eagle Lake near the eastern extent of the blowdown. White fir root decay varied in severity throughout the blowdown area depending on the location. Root decay was never observed in uprooted lodgepole pine.

In the Pacific Northwest, HRD primarily affects ponderosa pine on dry sites east of the Cascade crest, where it causes severe root and butt decay, tree mortality, and growth loss.

Even though HRD is present throughout Maine, there was no significant activity reported from surveys in 2015, as well as no new HRD reported in Vermont.



Figure 5. *Heterobasidion* root disease-induced mortality.

Photo by Joseph O'Brien, USDA Forest Service.



Figure 6. *Heterobasidion* fruiting bodies on subalpine fir on the Wasatch National Forest, UT.

Photo by USDA Forest Service.

Rapid Ōhi'a Death

Ōhi'a (*Metrosideros polymorpha*) is Hawai'i's most widespread native forest tree, spanning nearly a million acres across the State. It provides vital watershed functions, is important habitat for many native species, and is of tremendous spiritual and cultural significance. In 2014, a new fungal disease was identified as the cause of rapid Ōhi'a death (ROD), and its origin is still unknown (figs. 1 and 2).

The pathogen infects Ōhi'a primarily through open wounds—possibly created by high winds, animals, or equipment—and may take several months to spread into and clog the tree's water transport system. Once this occurs, the leaves quickly turn brown, defoliation follows, and the tree dies. Research suggests the conversion of native to invasive-dominated forests is the direct result of ROD.

ROD is currently found only on the Big Island of Hawai'i. In 2015, over 44,000 acres of Ōhi'a of all ages, in different

elevations and climates, were impacted. All of the mechanisms of disease spread are under investigation, but moving infected plants and logs can lead to spread and pathogen intrusion in soil, which can kill Ōhi'a seedlings. Quarantine rules restrict the movement of Ōhi'a plant parts (wood, seedlings, foliage, and flowers) from The Big Island.

There are currently no known treatments for infected trees at the landscape scale or to prevent forest infection, although researchers are testing injectable fungicides, soil drenches, heat treatment, and other treatments for commodities for inter-island shipment. Monitoring and genetic testing for possible disease resistance is also underway. Efforts to educate people about ROD and how to minimize spread are ongoing. The public's cultural and emotional connection to Ōhi'a has played a factor in the response and cooperation. (<http://cms.ctahr.hawaii.edu/rod/Home.aspx>)

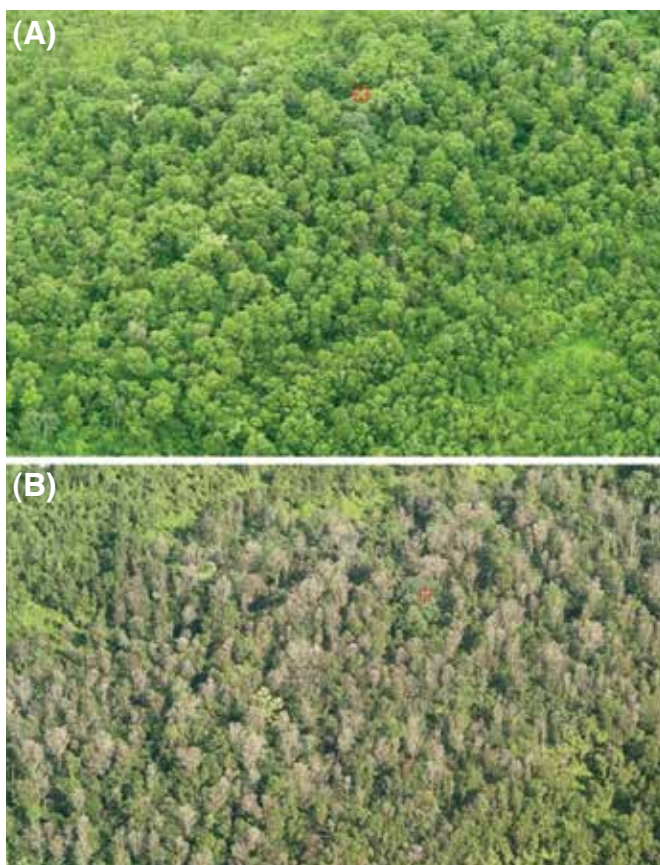


Figure 1. Ōhi'a forest in 2008 (A) and in 2012 (B) after rapid Ōhi'a death invasion. Pictometry courtesy of U.S. Geological Survey.



Figure 2. Rapid browning of Ōhi'a. Photo by J.B. Friday, University of Hawaii College of Tropical Agriculture and Human Resources.

