USDA
United States Department of Agriculture

Forest Health Highlights in Oregon—2016

Pacific Northwest Region
Forest Health Protection

for the greatest good

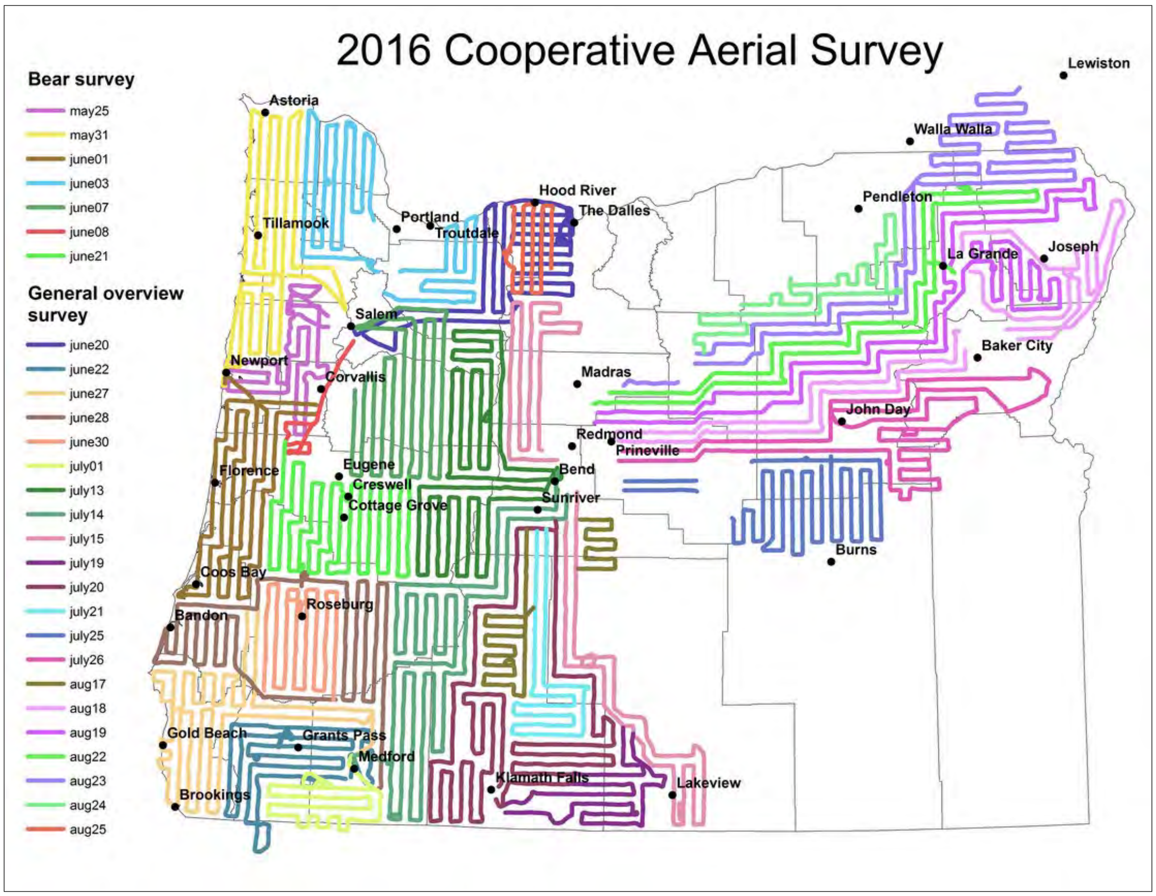
Oregon Department of Forestry
Forest Health Program

Forest Health Highlights
In Oregon – 2016

Joint publication contributors and collaborators:

Christine Buhl[1]
Alan Kanaskie[1]
Sarah Navarro[1]
Danny Norlander[1]
Wyatt Williams[1]
Zack Heath[2]
Robert Schroeter[2]
Ben Smith[2]
Oregon State University
USDA-Agricultural Research Service

[1]Oregon Department of Forestry
[2]U.S. Department of Agriculture, Forest Service



Front cover: *Black stain root disease, shown in Douglas-fir, is vectored by root-feeding bark beetles and weevils and attacks primarily Douglas-fir and ponderosa pine in Oregon. Black streaks indicate where the pathogen has colonized the tree's water conducting sapwood. (Photo by Alan Kanaskie, ODF)*

Table of Contents

Summary 2
Aerial and Ground Surveys 3
Climate and Weather 4
Drought Damage in Conifers 6
Fire 7

Forest Insects 9
Insect Damage Map 10
Bark Beetles 11
Douglas-fir beetle 12
Fir engraver 12
Mountain pine beetle 13
Western pine beetle 13
Ips beetles 13
Wood Boring Insects 14
Defoliators 15
Sap-sucking Insects 16

Forest Diseases 17
Sudden Oak Death 17
Swiss Needle Cast 20
Web Blight 22
Phytophthora Needle Cast 23
Incense Cedar Canker 24
Western Redcedar Decline 24
Blackstain Root Disease 25

Young Conifer Mortality (Bear damage) 26

Invasive Species 27
Gypsy Moth 27
Emerald Ash Borer 29
Invasive Woodborer Survey 29
Other Invasive Insects 30
Invasive Plants 31
Oregon Forest Pest Detector 32

Links to Additional Forest Health Information 33

Forest Health Contacts in Oregon ..... Back Cover

Summary

Insects, diseases, and other disturbance agents cause significant tree mortality, growth loss, and damage in Oregon forests each year. Large outbreaks can affect the function and resilience of forest ecosystems and may contribute to hazardous forest fire conditions. However, these agents also play a critical role in maintaining healthy, functioning forests by contributing to decomposition, nutrient cycling, and creating openings that enhance forest diversity and wildlife habitat. **A healthy forest is never totally free of damaging insects, diseases, and other disturbances.**

Oregon's forests cover approximately 30 million acres of the state and consist of federal (60%), private (35%), state (3%), tribal (1%), and other public (1%) ownerships. Western Oregon is characterized by high rainfall and dense conifer forests along the Pacific coastline, the Coast Range, and western slopes of the Cascade Range. Eastern Oregon largely consists of lower density, semi-arid forests and high desert. Statewide forest cover is dominated by conifers such as Douglas-fir, true firs, western hemlock, and ponderosa pine. The most abundant hardwoods are big leaf maple, red alder, Oregon white oak, and cottonwoods.

Of the 28 million total forested acres aerially surveyed in 2016, an estimated **705,000 acres with tree damage and mortality from diseases, insects and other animals** were detected. This total has increased for a third consecutive year:

2015: **698,000** 2014: **661,000 acres** 2013: **530,000** 2012: **615,000**

Although much of Oregon experienced lower average temperatures and higher precipitation in 2016 relative to recent years, most of the state is still in a drought. Oregon forests continue to experience fallout from several years of drought stress. Often, drought-stressed trees succumb to either direct damage from drought on vascular tissues, roots, foliage, etc., or secondary impacts from insects and pathogens that take advantage of reduced tree defenses.

Bark beetles contributed the majority of insect-related tree mortality but proportionately larger increases in insect-caused mortality were attributed to flatheaded fir borer, a wood boring beetle that attacks Douglas-fir. Native defoliators remained at endemic levels but also included an appearance by Pandora moth in central Oregon. Sap-sucking insects such as balsam woolly adelgid and black pineleaf scale continued to be a chronic problem in areas where they have become established. Aerial application treatments for Asian gypsy moth (AGM) were applied in the spring over approximately 9,000 acres in the Portland metro area after three adults were found in the area in 2015. No moths were captured following the treatments, indicating preliminary success of eradicating this species. No emerald ash borers were detected in the state, although other invasive insects were observed in the state through routing monitoring or landowner calls. In 2016, the EU1 lineage of the Sudden Oak Death pathogen was detected 1/2 mile south of the initial detection in 2015 - EU1 treatment is a top priority. Aerial detection of Swiss needle cast slightly decreased in 2016 relative to 2015 and 2014. Investigation continues on the spread and intensity of two foliage diseases affecting Douglas-fir (web blight and *Phytophthora* needle cast) as well as decline in Western redcedar.

Aerial and Ground Surveys

Determining the extent and severity of forest damage from insects and diseases through surveys is an important step in prioritizing and planning management and other actions. The Oregon Department of Forestry (ODF) works cooperatively with the USDA Forest Service (USFS) and other organizations to annually monitor forests in Oregon. Aerial and ground surveys are used to detect and evaluate forest conditions throughout the state. This report provides an overview and summary for many of the major agents observed during 2016.

Forest Resources, Inventory and Analysis

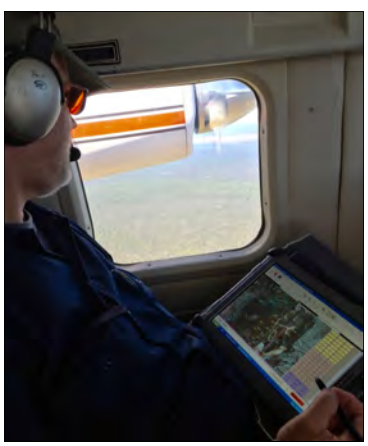
The USDA Forest Service Forest Inventory and Analysis (FIA) program monitors change to Oregon's forests through ground surveys within a national grid of permanent plots. A systematic sub-sample of the plots in Oregon are measured annually until each has been inventoried. Each plot is measured once during the 10 year sampling cycle. FIA plot data are comprehensive and include quantitative measurements of forest condition and health, and often identification of damaging agents that cannot be observed using aerial surveys. For more information, visit: http://www.fs.fed.us/pnw/rma/fia-topics/index.php

Aerial Survey

Aerial surveys of damage from insects and diseases in Oregon have been conducted since 1947. In 2016, surveys were flown by the USFS and ODF between June and September and covered about 35.5 million acres in Oregon.

Survey target	Total acres	Total hours
Statewide Survey	35,598,000	131.4
Swiss Needle Cast	4,221,000	30.7
SOD Fixed-wing	400,000	5.5
SOD Helicopter	630,000	19.4

Aerial observers estimated 705,384 acres with damage (or about two percent of the area surveyed), which is below the 10-year average of approximately 825,000 acres. This damage includes mortality or defoliation resulting from a wide range of diseases, insects and other animals, as well as environmental damage.



Christine Buhl, ODF

Figure 1. *Aerial surveyor mapping damage.*

Although the statewide general survey is the longest running, ODF also conducts specialized surveys including Swiss needle cast and sudden oak death. The Swiss needle cast survey comprised 4.2 million acres of the coast range and portions of the Cascade foothills. During this survey, about 550,000 acres of moderate and high disease severity was observed.

Sudden oak death was first detected in Oregon during an aerial survey and has subsequently been incorporated into an ongoing effort to locate and delimit the range of the infestation in Curry County. Both fixed wing and helicopter surveys are used each year to conduct several surveys that cover approximately 1 million acres.

Additional details on the various surveys are available in various standalone reports produced by ODF.

Climate and Weather

Drought Conditions Continue

In 2016 Oregon received a bit of a break in terms of temperature and precipitation relative to the prior three years of intense drought. However, much of the state is under drought conditions as defined by above average temperatures and below average rainfall (Figure 2).

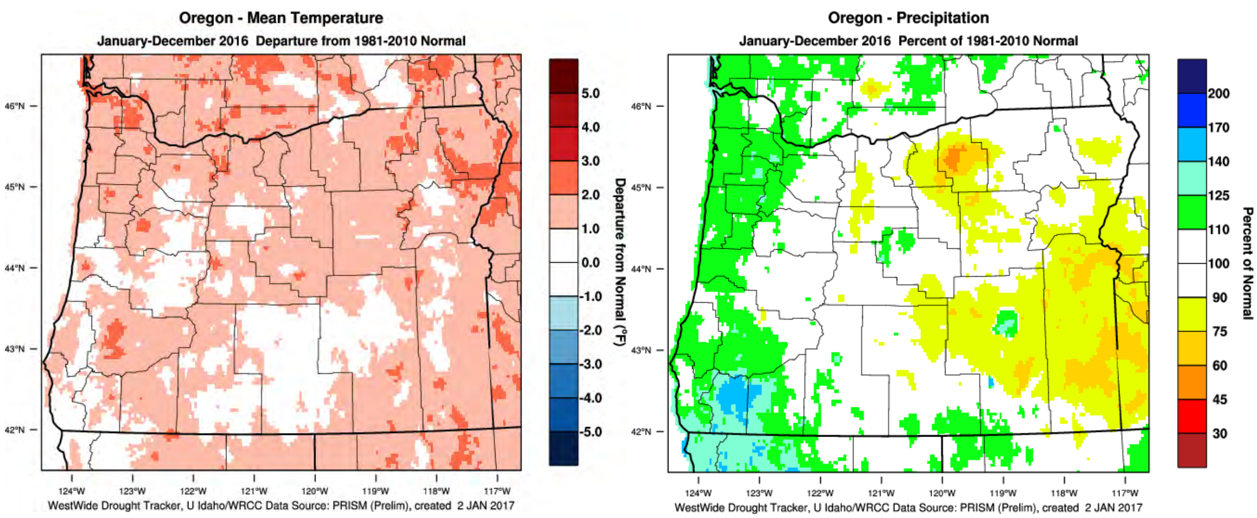
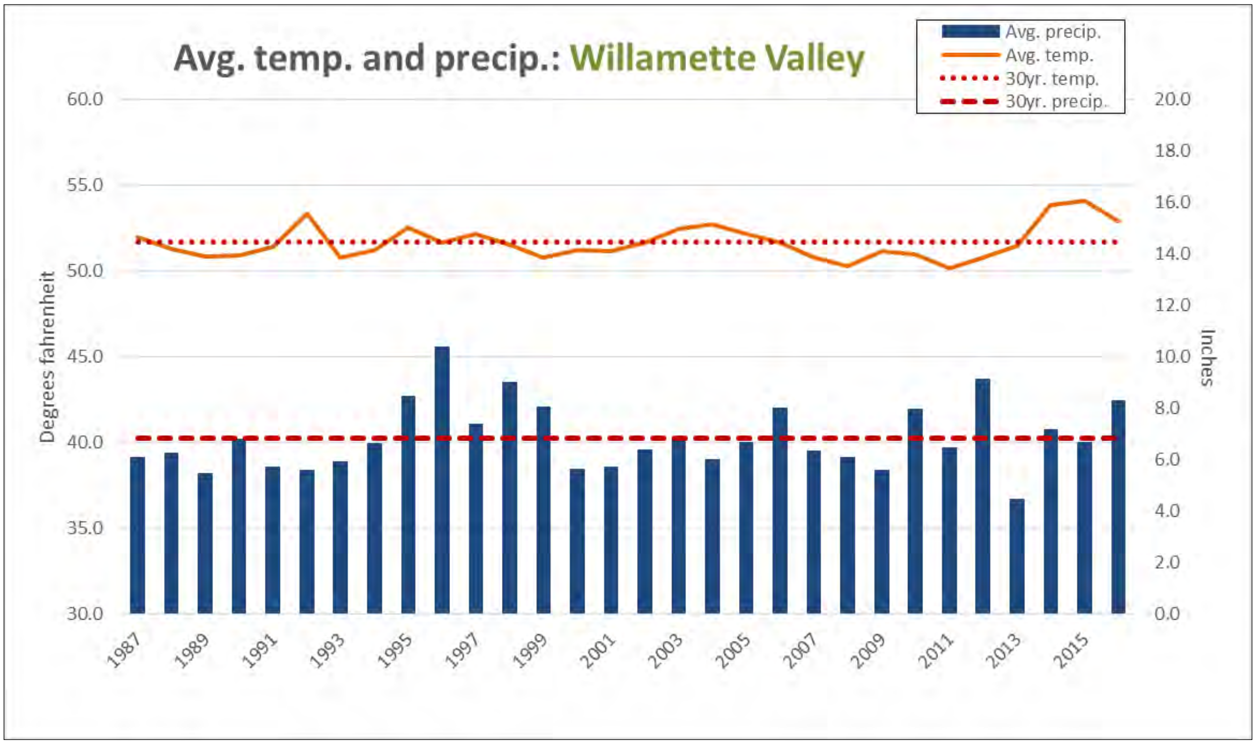


Figure 2. *Temperature (left) and precipitation (right) maps for Oregon showing conditions from January - October 2016 relative to averages from 1981-2010. Data from Western Regional Climate Center WestWide Drought Tracker.*

Because Oregon has a diversity of ecotypes, drought severity varies throughout the state. Latitude, elevation, topography, proximity to the ocean, etc. all play a role in determining the impacts of altered temperatures and precipitation (rain and snow) levels. Additionally, factors such as soil and groundcover type, local water use and watershed dynamics can place different pressures on water storage capacities. The rain shadow effect of the Cascade Range constitutes one of the larger influences on climate and the variable ecoregions found in the state.

Ecoregions on either side of the Cascades show similar 30-year trends in average temperature and precipitation (Figure 3, next page), but differing intensity. Average temperatures in 2014 and 2015 were higher in both regions than what were seen in the past 30 years. Average precipitation was below the 30-year average for both regions in 2013 and 2015. Precipitation in the Willamette Valley hit it's lowest point in at least 30 years in 2013, and was 30% lower than the 30-year average. Such extreme conditions have weaken and killed many trees that previously were thriving. The duration of drought may be finite but the effects on trees are long -lasting. A surge in rain after a drought period (as we have had in the fall and winter of 2016) may mitigate but cannot completely reverse damage already caused by drought.



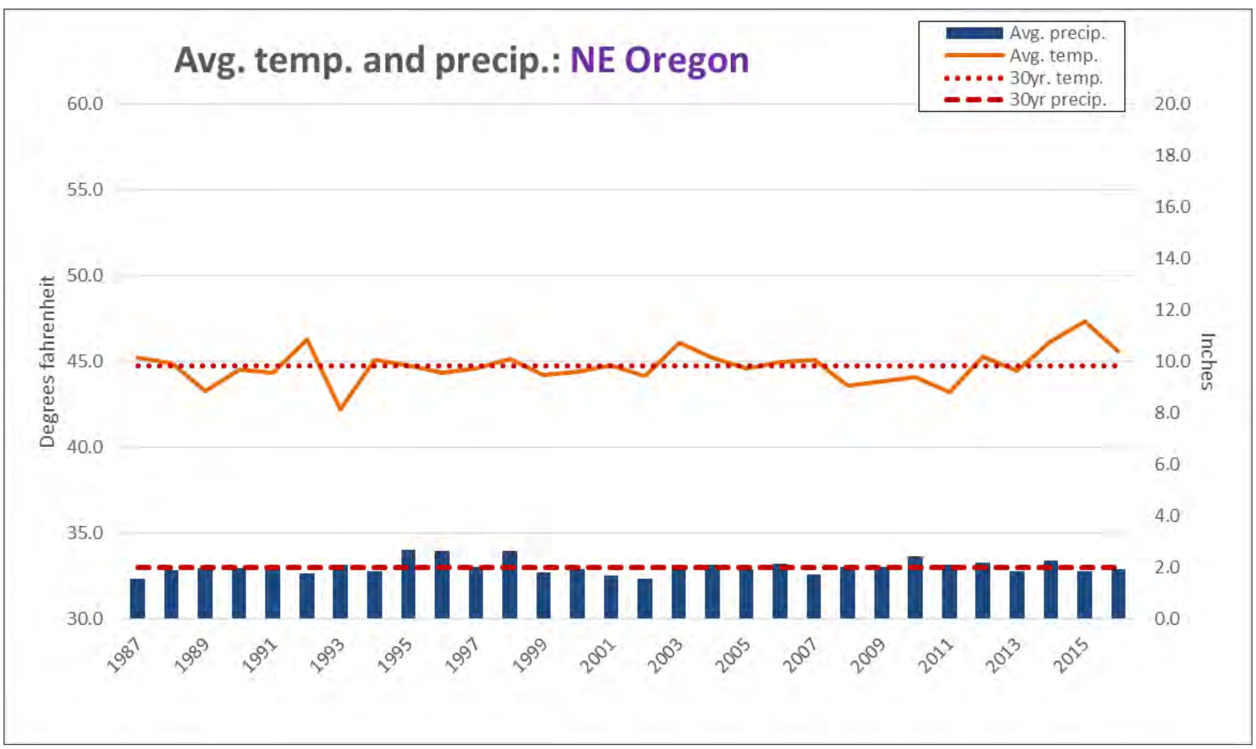


Figure 3. *Raw annual average temperature and precipitation over the last 30 years in the Willamette Valley and northeastern Oregon ecoregions. Data from National Oceanic and Atmospheric Administration.*

Drought Damage in Conifers

Despite higher levels of precipitation in 2016 relative to recent years, many trees are still recovering from several years of drought stress. Drought can cause long-term impacts such as collapsed vascular systems and atrophied roots, which contribute to reduced resiliency despite increases in precipitation. These drought-stressed trees are also less capable of maintaining mechanical and chemical defenses such as sap and anti-herbivore leaf compounds that ordinarily deter insect pests. Symptoms of drought usually become apparent in spring and early summer of the year following drought conditions (Figure 4).

In 2016 we continued to see drought-related damage in the form of dieback, topkill and whole-tree mortality particularly in Douglas-fir in the Willamette Valley, central Oregon near Warm Springs and in SW Oregon. Other species such as western redcedar, grand and noble firs, and red alder also displayed symptoms of drought. Even typically drought-tolerant pine species in eastern Oregon appeared to be less resilient than usual. Often drought damage was accompanied by the presence of secondary insects and/or diseases such as cankers.

Robbie Flowers, USFS

Figure 4. *Flagging in drought-damaged Douglas-fir.*

The best methods to reduce the impact of drought on trees:

1. Select native *and* local, drought-tolerant species and cultivars that are appropriate for your site and soil conditions. On sites where Douglas-fir mortality is occurring it may be advisable to plant ponderosa pine (or the Willamette Valley ponderosa pine cultivar in the valley) or Oregon white oak.
2. Thin stands during normal years, not within a drought if possible (thinning can cause a short-term increase in water stress). Remove damaged, stressed or overly mature trees.
3. Control vegetation (especially grasses) that compete for soil moisture.
4. Remove or destroy freshly dead, dying trees and slash or blowdown created in the previous year to prevent insect infestations and outbreaks. Old dead trees are not a risk.
5. Avoid mechanical damage and soil compaction around tree root zones (from vehicles, grazing animals, etc. – especially during the wet season).
6. Irrigate landscape trees during dry weather. Apply water slowly over many hours so it penetrates to tree roots, or use drip irrigation.
7. Apply mulch to landscape trees to retain soil moisture.
8. Do not alter drainage patterns (ditches, ponds, etc.) near established trees.
9. Do not fertilize during droughts. Fertilization stimulates foliage production and can increase water requirements.
10. Systemic pesticides used to prevent or control insect pests may be less effective because they rely on water for translocation to all tissues.

More info on drought at http://tinyurl.com/odf-foresthealth

Fire

Across all ownerships in Oregon there were 1,669 fires reported that burned over 192,500 acres in 2016, the lowest since 2010 (Figure 5, Figure 8 next page). Lightning-caused fires contributed to more acres of damage when averaged over number of fire starts, although 80% of the number of Oregon wildfires in 2016 were human-caused. Fire starts from debris burning and abandoned campfires are of particular concern.

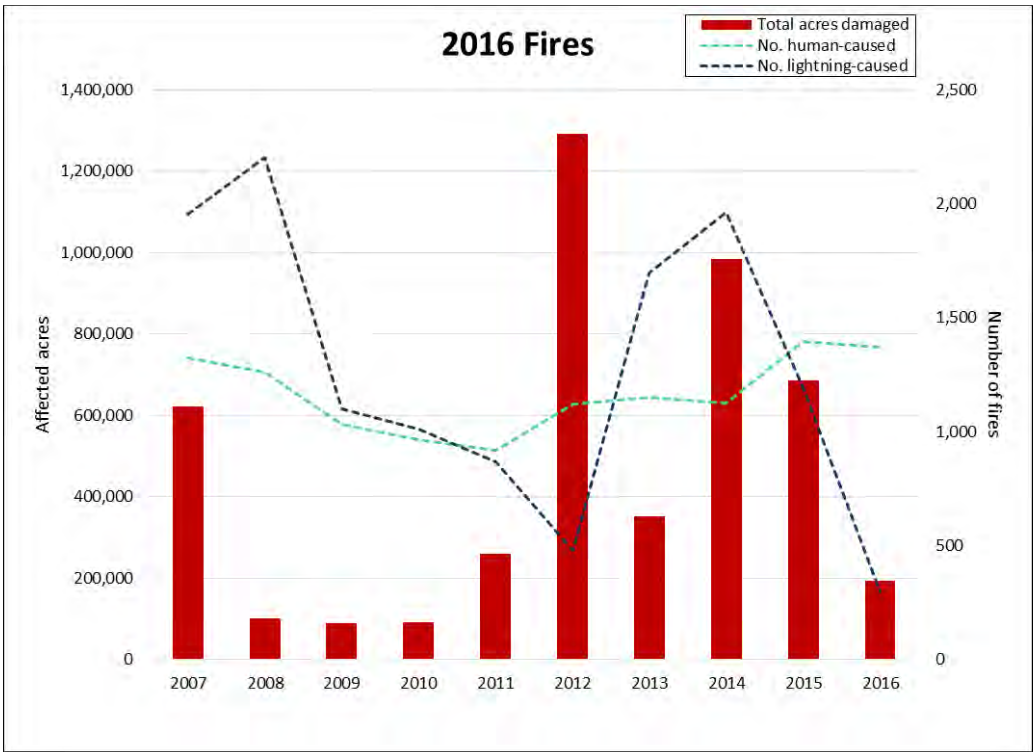


Figure 5. *10-year trend for total acres across all ownerships damaged by wildfire (left axis) and number of human- and lightning-caused fires (right axis). Data from ODF Protection and NWCC.*

Fire suppression costs are substantial ($13.2 million in 2016), but the cooperative and immediate response efforts among ODF, USFS, Oregon Department of Corrections (DOC) fire crews, and many other cooperators and contractors minimized the number of large fires and successfully extinguished 97% of all fires at 10 acres or less (Figure 6). The lack of dry lightning played a significant role in keeping down firefighting costs this season.

ODF Protection

Figure 6. *ODF Klamath hand crew.*

Fire damage is a common stressor that predisposes trees to mortality from secondary agents such as wood-infesting beetles. There are many regional and species-specific post-fire mortality ratings available to determine if trees will die as a result of 1) direct fire damage or 2) secondary infestation from insects (Figure 7). Scorching of the crown kills needles and buds which reduces photosynthesis and new growth. Scorching of the bole kills cambium and vascular tissues which transport water and nutrients, effectively girdling a tree. As long as moist or living phloem remains, insects such as bark beetles or wood borers such as the flatheaded fir borer can attack trees that may otherwise have survived.

Christine Buhl, ODF

Figure 7. *Large, pinkish pitch tubes and granular frass are signs of red turpentine bark beetle. This secondary pest commonly attacks fire damaged trees that are close to dying.*

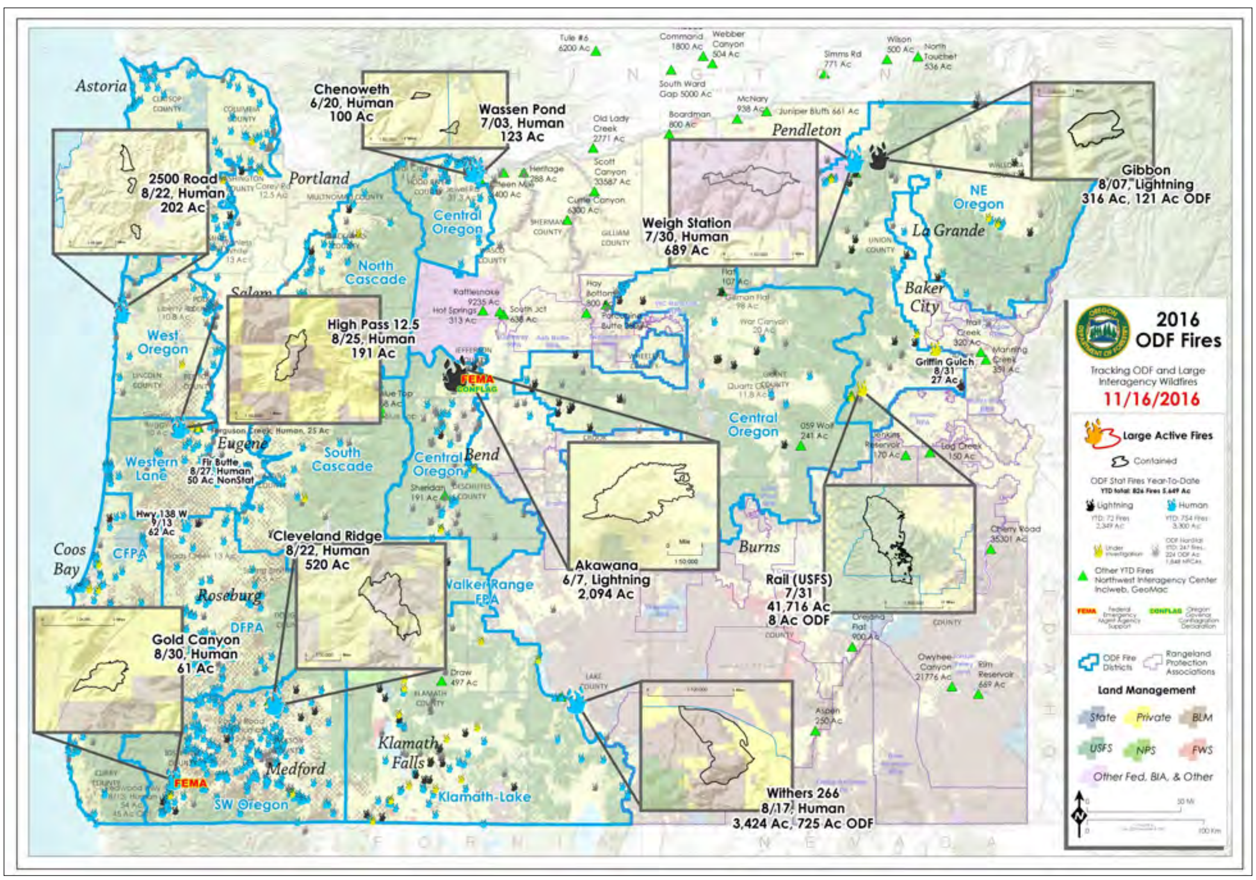


Figure 8. *Map of major wildfires in Oregon in 2016 showing perimeters, acreage, causation with date. Outbreaks from bark beetles are common along fire perimeters where trees have been damaged but are not yet dead.*

Insects

Outbreaks of forest insects occur periodically in Oregon and historically have resulted in significant tree damage or mortality. In 2016, statewide aerial surveys detected 647,000 acres with damage or mortality from forest insects (Figure 9), which represents 90% of the total damage identified in the statewide survey of forest health in Oregon.

Bark beetles, followed distantly by sap-sucking insects, caused the majority of aerially-detected tree mortality in Oregon forests in 2016. Although total insect-caused mortality in 2016 was below the 10-year average, trends indicate increasing insect damage— particularly from bark beetles and a type of wood boring beetle.

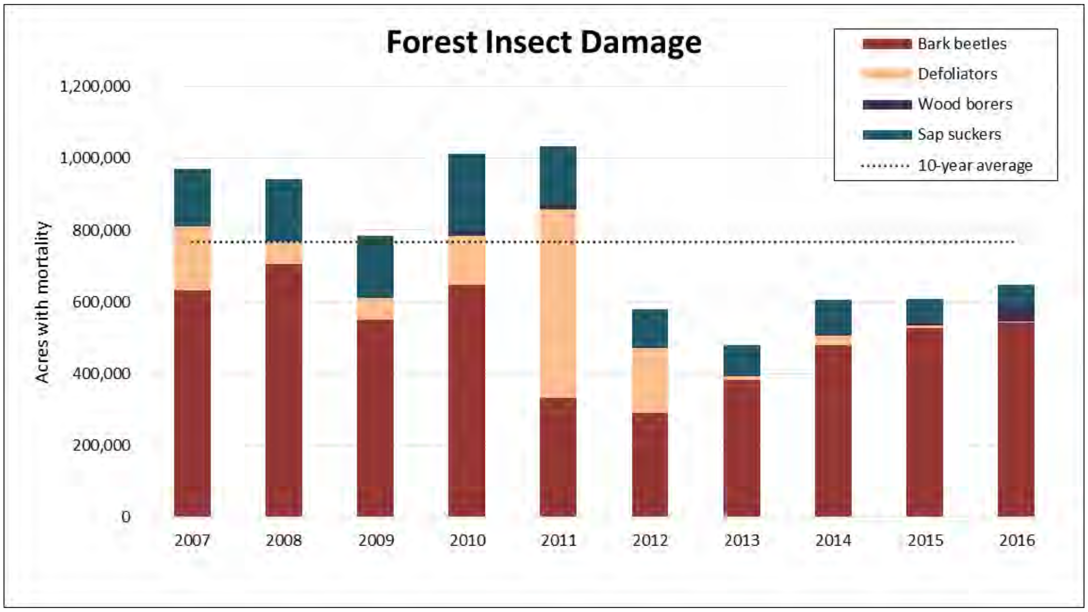


Figure 9. *Ten-year trend for insect damage in Oregon forests. Data from statewide aerial survey.*

Currently the most damaging **bark beetles** include Douglas-fir beetle, mountain and western pine beetles, *Ips* beetles and fir engraver beetles. Estimated tree mortality caused by these bark beetles, with the exception of mountain pine beetle, increased in 2016.

Within the **wood boring beetles** group, the primary mortality-causing species is the flatheaded fir borer. This insect caused five times more mortality in Douglas-fir in 2016 than in 2015.

Trends for **sap-sucking insects and defoliators** both decreased for a second year, although infestations of sap-sucking insects such as the exotic balsam woolly adelgid and black pineleaf scale continue to be chronic in some areas. Defoliator outbreaks are often cyclical and isolated. Pandora moth larvae made an appearance in 2016 following a peak in adults the year before, as part of their 2-year developmental cycle.

Insect Damage Map

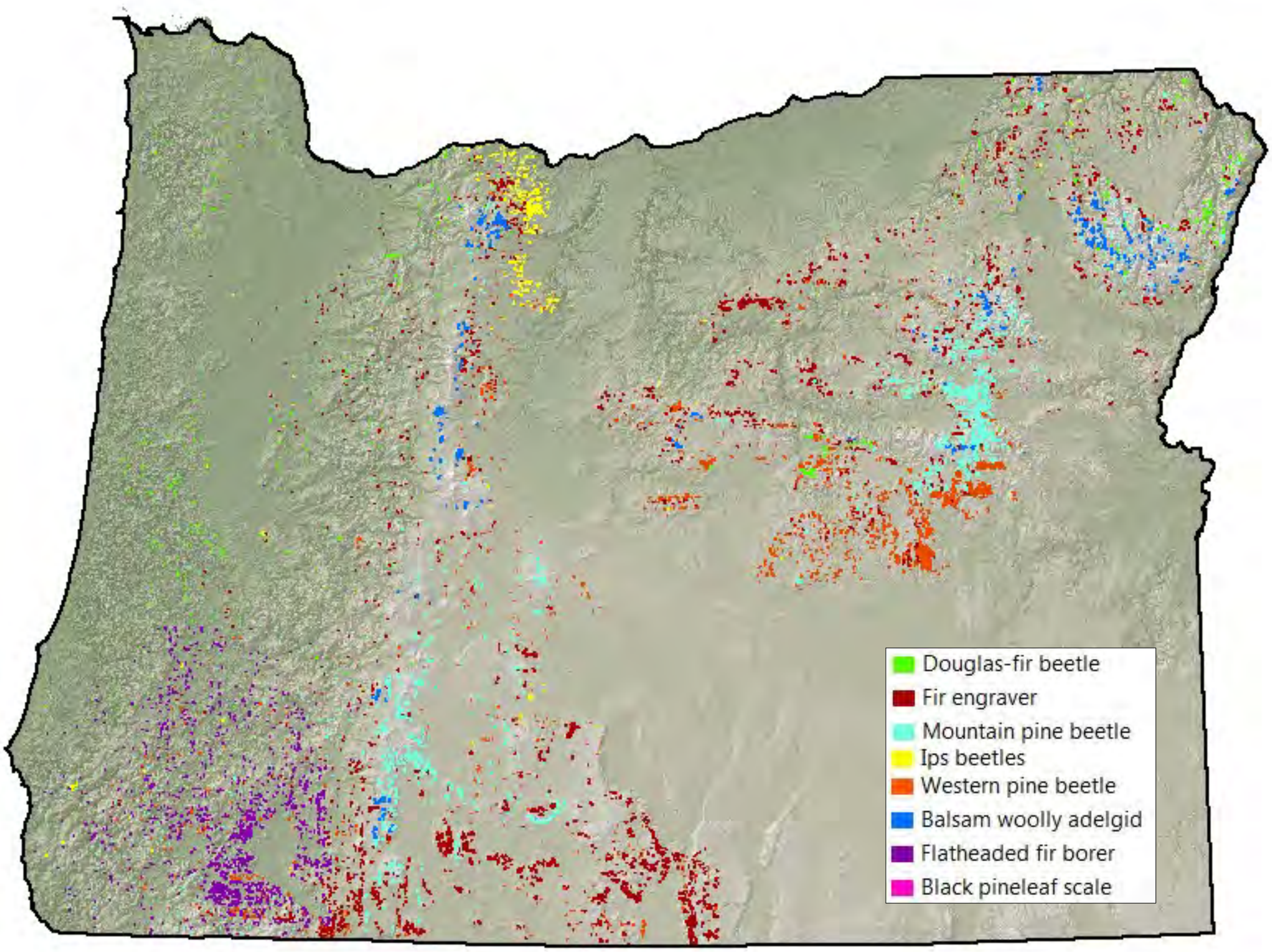


Figure 10. *Map of forest insect damage in 2016. Data from statewide aerial survey.*

Bark Beetles

Figure 11. *"Bluestain" or "sapstain" are terms often used for types of fungi that clog vascular tissues, these fungi are vectored by bark beetles.*

Bark beetles are tiny beetles that typically create extensive tunnels of brood galleries under bark (not within wood), which girdle vascular tissues. These beetles can also vector various types of stain-causing fungi (Figure 11) that clog (but do not decay) vascular tissues, which hastens tree death. When trees have been sufficiently weakened by bark beetles they often are subsequently attacked by wood boring beetles that typically tunnel into the wood. Stains and damage from wood borers can greatly devalue timber.

The most damaging bark beetles that are primary pests in Oregon forests include Douglas-fir beetle, mountain and western pine beetles and *Ips* beetles (Figure 12). Secondary bark beetles that may become more problematic in heavily stressed trees include Douglas-fir pole beetle, Douglas-fir engraver beetle, fir engraver and red turpentine beetle, among others. The presence of these secondary bark beetle pests may also indicate prior infestation and weakening of trees by primary bark beetle pests.

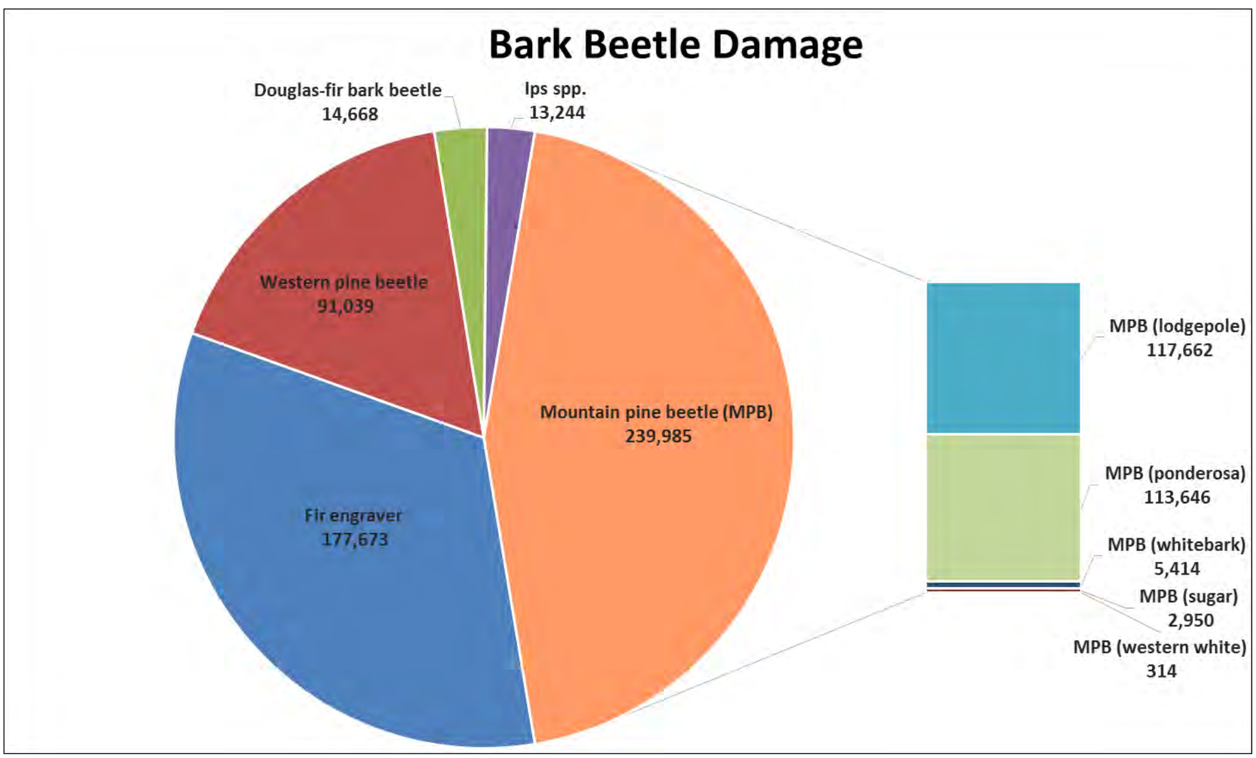


Figure 12. *Acres with tree mortality caused by bark beetles, with breakout column of hosts attacked by mountain pine beetle. Data from statewide aerial survey.*

Douglas-fir beetle (*Dendroctonus pseudotsugae*) is a primary mortality agent in Douglas-fir (*Pseudotsuga menziesii*) and is associated with blowdown events, root disease, fires or defoliation. Outbreaks following stress events can last up to four years. Douglas-fir trees stressed by recent droughts were often killed by this pest, sometimes in combination with flatheaded fir borers. Management strategies for this pest include: removal of stressed Douglas-fir, reduction of the Douglas-fir component in pine-oak habitats, appropriate management of root diseases, removal of >8” diameter downed trees and/or utilization of the anti-aggregation pheromone MCH (Figure 13) following storm events.

Christine Buhl, ODF

Figure 13. *MCH anti-aggregation pheromone repels Douglas-fir beetle.*

More info on MCH at http://tinyurl.com/odf-foresthealth

Fir engraver (*Scolytus ventralis*) can infest all species of true fir (*Abies* spp.) in Oregon, but most commonly affect grand, white, and noble firs in forest settings. This secondary agent usually causes strip attacks that kill attacked portions of trees but always not the whole tree. The appearance of dead tree tops or branch flagging (Figure 14) often indicates infestation by fir engraver. This pest is strongly associated with drought stress and has been on the rise in correlation with intensifying drought conditions. Acres of mortality attributed to fir engraver, as detected by aerial survey, indicate a 20-fold increase from 2012 to 2016. Increased mortality is expected from this pest particularly on droughted sites with dense stands of true fir.

Kenneth Gibson, USFS, Bugwood.org

Christine Buhl, ODF

Figure 14. *Top kill and branch flagging (left) and galleries (right) from fir engraver attacks.*

Several other bark beetle species are primary pests of pine, most of which attack multiple pine species and can overlap with each other within the same tree. Determining the causal agent can be difficult from aerial surveys but ground checks can assist with verification where aerial signatures are not definitive.

Mountain pine beetle (*Dendroctonus ponderosae*) is most often associated with overly dense or mature lodgepole pine (Figure 15), but will also infest large-diameter ponderosa as well as the 5-needle pines (sugar, western white and whitebark). Mountain pine beetle-caused mortality has declined for the second year in a row, most likely due to the loss of preferred hosts from previous attacks rather than from improving conditions. Despite decreases in total mortality from this pest, mortality in the critically threatened whitebark pine changed little relative to 2015.

Figure 15. *Mountain pine beetle pitch tubes in lodgepole pine.*

Figure 16. *Woodpeckers flake away bark to reach western pine beetles.*

Western pine beetle (*Dendroctonus brevicomis*) attacks large-diameter ponderosa pine stressed by drought, fire, defoliation and root disease. Larvae of this insect will move to the outer bark during latter stages of development, leaving them exposed to woodpeckers that flake off the bark in search of grubs (Figure 16). Evidence of wood flaking is often an indication of infestation by western pine beetles. Mortality from western pine beetle increased for the fourth consecutive year in 2016. In 2015 mortality from this pest increased from the previous year by a factor of four, and this year mortality rose by only 15%. Despite this small increase in 2016, total affected acres is still double that of the 10-year average.

Two major ***Ips*** **beetle** species in Oregon are the pine engraver (*Ips pini*) and the California fivespined Ips (CFI; *I. paraconfusus*). Both prefer to attack green slash, branches and the tops of ponderosa and other pine species. Death of the top 1/3 of a pine is often a symptom of an Ips infestation (Figure 17). Outbreaks can last 1-3 years depending on the species, although areas along the Columbia River Gorge have been experiencing a continuous CFI outbreak since 2010. Isolated outbreaks occurred widely throughout the Willamette Valley in 2016, often as a result of overstocking of young pine stands and improper management of slash.

Figure 17. *Topkill in ponderosa pine from* Ips *beetles.*

More info on slash management at
http://tinyurl.com/odf-foresthealth

Wood Boring Insects

Wood boring insects include ambrosia beetles, roundheaded borers/longhorned beetles, flatheaded borers/metallic wood boring beetles, wood wasps and wood boring larvae of moths. These insects, with exceptions, bore through bark and into the wood. While many of these insects are not primary causes of tree mortality and are actually beneficial for wood decomposition and nutrient cycling, one species, the flatheaded fir borer, is a primary pest of Douglas-fir.

Unlike other wood borers the **flatheaded fir borer** (*Phaenops drummondi*) does not tunnel into the wood, instead it behaves like a bark beetle and creates galleries just beneath the bark (Figure 18). This insect is a major pest of Douglas-fir growing below 3,500 feet elevation on dry, poor quality sites. The most severe damage from this pest tends to occur in the Klamath-Siskiyou and South Cascade ecoregions and has been low, historically. However, mortality from this pest jumped from 8,000 acres in 2015 to 45,000 acres in 2016. Much of this mortality is as a result of Douglas-fir growing on harsh sites more suited to pine and white oak, with the added stress of drought (Figure 19). Sites with thin soils, sunny exposures or low moisture availability are inhospitable to Douglas-fir and decrease resilience to pests such as the flatheaded fir borer. Fire damage also predisposes Douglas-fir to this pest.

Bill Schaupp , USFS

Figure 18. *Flatheaded fir borer galleries located just beneath the bark.*

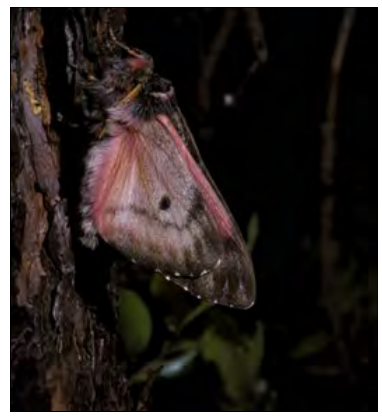
Bill Schaupp, USFS

Figure 19. *Flatheaded fir borer-caused mortality on a south-facing slope between Applegate and Provolt in southwest Oregon.*

Defoliators

Historically, principal forest defoliators in Oregon include western spruce budworm, Douglas-fir tussock moth, pine butterfly and various sawfly species. Defoliators of hardwoods typically do not cause mortality unless trees are severely stressed by other factors. Defoliation is particularly damaging to conifers, because unlike deciduous trees, they cannot reflush a full complement of foliage each year to restore foliage lost to herbivory. Defoliation not only reduces growth but may also increase susceptibility to other pests such as bark beetles. Outbreaks of defoliators are often cyclical and may last for multiple years. In 2016, only Pandora moth made a notable appearance.

Pandora moth (*Coloradia pandora*, Figure 20) is a defoliator seen infrequently, but in 2015 elevated numbers of adults were detected near light sources near Bend and Chemult. In 2016 large numbers of larvae accompanied by some defoliation were seen in these areas. This insect has a 2-year life cycle in which larvae occur in even years and adults in odd years in Oregon. Larvae feed on mature ponderosa, Jeffrey, lodgepole and sugar pine growing in loose volcanic or limestone-based soils. Mature larvae and pupae are traditional foods collected by several native American tribes such as the Paiute, Klamath and Modoc. The last outbreak of this insect was from 2004-2008 in central Oregon.



William Ciesla, For. Health Mgt. Int., Bugwood.org

Figure 20. *Pandora moth adult.*

Douglas-fir tussock moth (*Orgyia pseudotsugata*) each year early detection traps are set by cooperators around approximately 450 forested sites east of the Cascades to detect building populations and predict impending outbreaks (Figure 21). Outbreaks from this pest last 1-2 years, the last of which occurred in 2011.

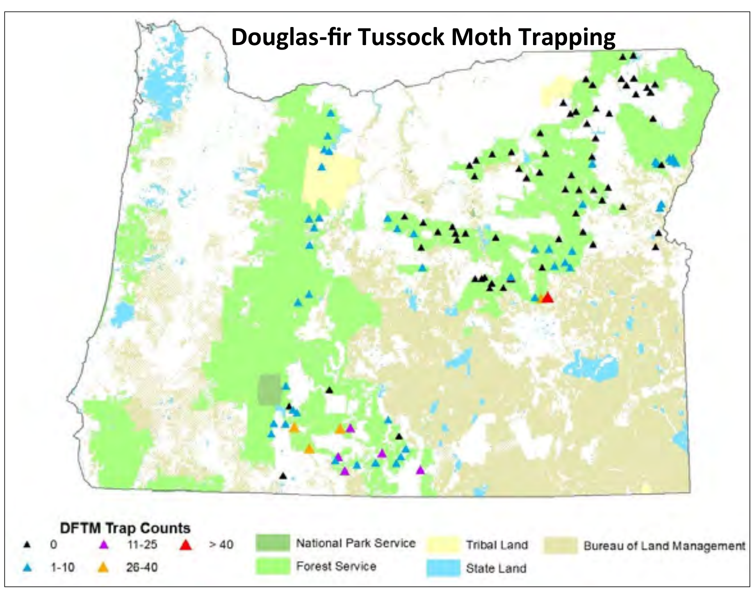


Figure 21. *Map of Douglas-fir tussock moth trap locations, color-coded by average number of moths caught in each trap at each site (five traps are set at each individual site). Data from USFS.*

Sap-sucking Insects

Sap-sucking forest insect pests of most concern are scales, aphids and adelgids (similar to aphids). Feeding may cause yellowing needles, needle loss, sooty mold growth on their liquid wastes (i.e., “honeydew”), tip dieback and reduced tree growth from chronic infestations. These pests are mostly stationary and may become established in an area, therefore becoming a chronic issue in true fir stands. Sap-sucking insect populations typically are held in check by parasitoids and predators. Drift from agricultural insecticide applications can inadvertently depress natural enemy populations and exacerbate sap-sucking insect outbreaks.

Beth Willhite, USFS

Figure 22. *‘Violin silhouetted’ crowns and dark color can signal balsam woolly adelgid infestation.*

Balsam woolly adelgid (*Adelges piceae*) is not native to Oregon but has been established on the West Coast since 1929. This pest attacks various true firs in Oregon. It feeds by piercing through bark causing swelling and dieback on stems and branches. Chronic damage can distort crowns and cause premature needle drop, which unveils dark lichens present in the crown giving trees a dark, purple color (Figure 22). Damage from the balsam woolly adelgid continues to be widespread and is currently affecting subalpine and Pacific silver firs at high elevations across central and eastern Oregon. Damage from this pest dropped in 2016 for first time in three years, and is 50% less than the 10-year average. However, decreased damage may be due to the loss of hosts.

Black pineleaf scale (*Nuculaspis californicus*) primarily infests ponderosa pine (Figure 23) but may also attack lodgepole pine, Douglas-fir and white fir. Infestations from this pest are not widespread but can become concentrated and chronic in isolated areas often near agricultural areas. Heavy pockets of infestation are often seen in Hood River and on harsh, scabby sites in the northeast.

Christine Buhl, ODF

Figure 23. *Large black pineleaf scale (left) infestations can cause older needles to drop, resulting in a ’lion’s tail’ appearance in branches (right).*

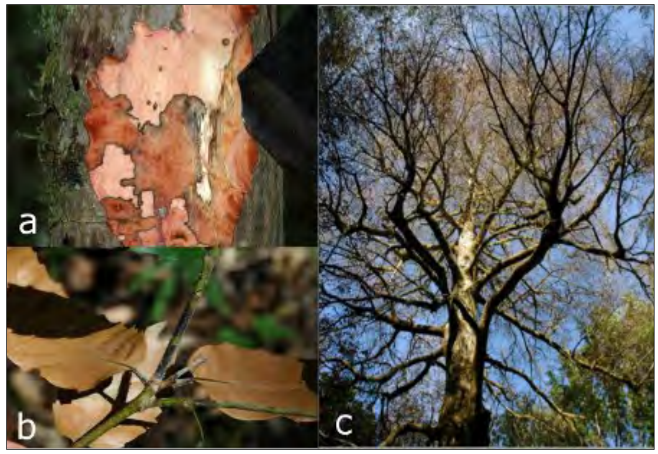
Symptoms of infestation may include discoloration or shedding of needles.

More info on all of these insects at http://tinyurl.com/odf-foresthealth

Diseases

Sudden Oak Death

Sudden Oak Death (SOD), caused by the non-native pathogen *Phytophthora ramorum,* kills highly susceptible tree species such as tanoak, coast live oak, and California black oak by causing lesions on the main stem (Figure 24). It also causes leaf blight or shoot dieback on a number of other hosts including rhododendron, evergreen huckleberry, Douglas-fir, grand fir and Oregon myrtle (Figure 25). In Oregon forests these hosts are only infected when growing very near infected tanoaks.



Alan Kanaskie, ODF

Figure 24. *Sudden Oak Death symptoms on tanoak - (a) stem canker, (b) foliar dieback, (c) dead tanoak with red leaves.*

P. ramorum spreads during rainy periods when spores produced on infected leaves or twigs are released into the air and are either washed downward or transported in air currents. The pathogen can survive for months or years in soil or plant parts. The disease also can be spread by humans transporting infected plants or infested soil.

Alan Kanaskie, ODF

Figure 25. *Foliar symptoms of SOD - (a) Douglas-fir, (b) Oregon myrtle, (c) rhododendron, (d) grand fir*

SOD was first discovered in coastal southwest Oregon forests in July 2001. An interagency team attempted to eradicate the pathogen though a program of early detection surveys followed by mandatory destruction of infected and nearby host plants. Even though eradication treatments eliminated disease from many infested sites, the disease continued to spread slowly in a predominantly northward direction and up major river drainages, following the pattern of winds that prevail during storms and wet weather. Continued spread of sudden oak death is attributed to limited budgets and the slow development of symptoms in infected trees, which hinders early detection as well as delays completion of eradication treatments.

From 2001-2009, all infested sites received mandatory eradication treatments. In 2010, disease levels exceeded the capacity to apply eradication treatments to all infested sites on private land, so sites near the center of the quarantine were left untreated in order treat higher-priority infestations near the quarantine boundary. In 2012, the quarantine regulations were changed and a Generally Infested Area (GIA) was declared in which eradication treatments were no longer required on private land (Figure 26). All sites on federal land continued to be treated, regardless of location.

In 2015, the quarantine area was expanded from 264 mi^2 to 515 mi^2 because of the distribution of newly infested sites discovered in 2014. In 2016, 64 new infestations were detected at or beyond the boundary of the GIA but well within the quarantine boundary (Figure 27, next page). Compared to the 18 new infestations detected in 2015, the disease appears to be intensifying in Curry County.

Sarah Navarro , ODF

Figure 26. *Tanoak mortality inside the Generally Infested Area increase risks of wildfire and damage to property from falling trees. Grey trees in the photo (taken October 2016) are dead tanoaks.*

In early 2015, another lineage of *P. ramorum* (EU1) was detected on a single tanoak. In Europe, the EU1 lineage kills or damages several conifer tree species and is considered more aggressive than the North American lineage (NA1). Establishment of the EU1 lineage would create the potential for sexual reproduction and increased variability in the current *P. ramorum* population. In 2016, the EU1 lineage was detected for a second time, ½ mile south of the one EU1-infested tanoak found in 2015. Of the 25 positive trees identified, two grand fir seedlings and 23 tanoaks are confirmed positive for EU1, while the lineage result for one tanoak could not be determined using current laboratory methods. The 2016 EU1 infestation is the top treatment priority and will include a 300-600 ft treatment buffer, resulting in a 54-acre treatment.

SOD is a tremendous threat to tanoak ecosystems in Oregon and California, and to forests elsewhere in the U.S. and abroad. If allowed to spread it will seriously damage the ecology of southwest Oregon forests, and the resulting quarantine regulations will disrupt domestic and international trade of many forest and agricultural commodities.

More info on SOD at:
http://www.oregon.gov/oda/cid/plant_health/sod_index.shtml
http://www.aphis.usda.gov/plant_health/plant_pest_info/pram/
http://www.suddenoakdeath.org

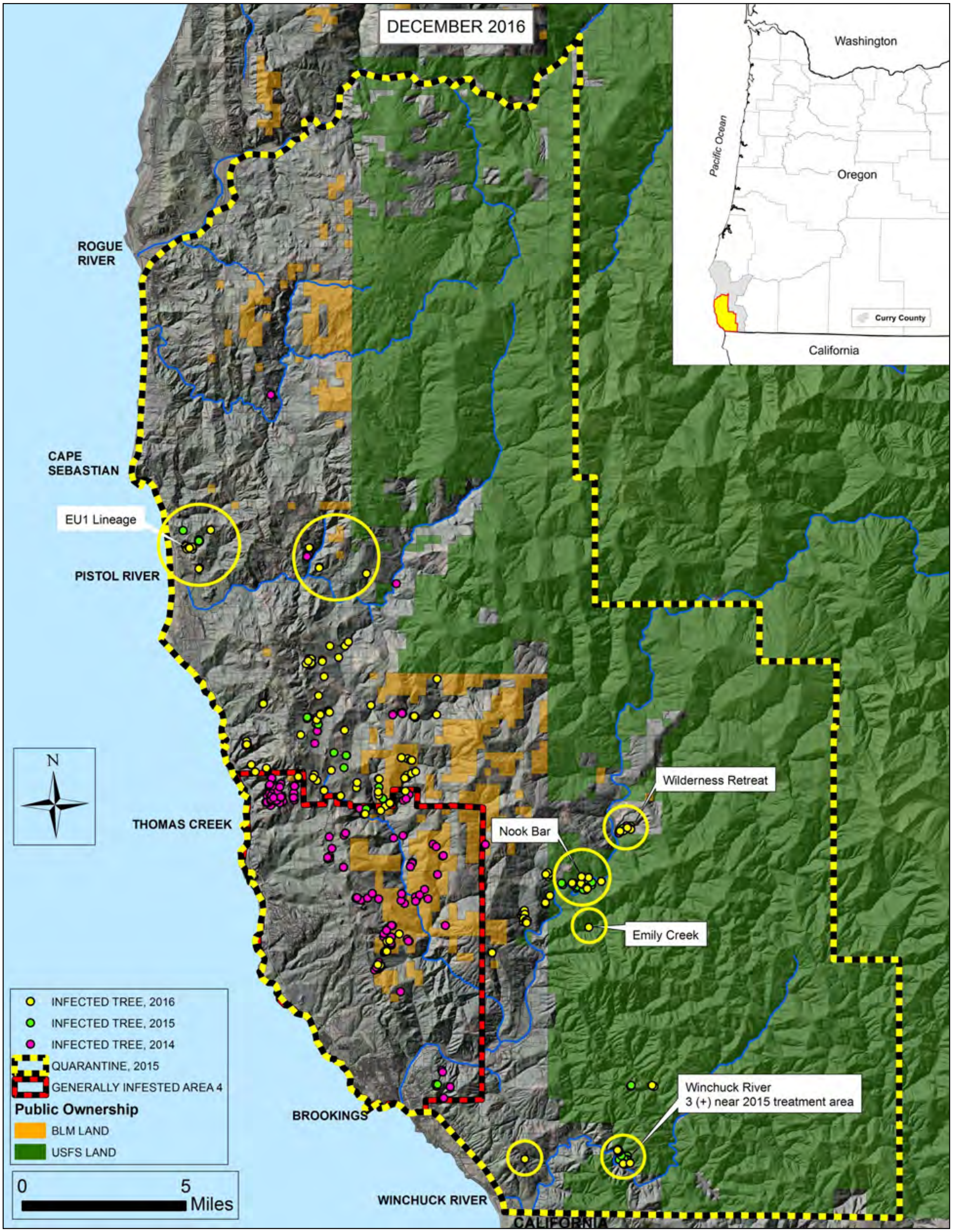


Figure 27. *Quarantine boundary and location of trees infected with* P. ramorum *that were found in 2016. The infestation is more widespread inside the Generally Infested Area (GIA) than shown on the map, due to decreased survey effort there. High priority treatment areas are indicated by the yellow circles. Data from SOD aerial, stream and ground surveys.*

Swiss Needle Cast

Alan Kanaskie , ODF

Figure 28. *SNC causes foliage loss and sparse, yellow crowns in Douglas-fir, which greatly reduces volume growth.*

Swiss needle cast (SNC) is caused by the native fungus *Phaeocryptopus gaeumannii* and affects only Douglas-fir. Symptoms are yellowing and premature needle loss (Figure 28).

Foliage loss does not directly kill trees, but can reduce tree volume growth by more than 50% and decrease long-term survival. Growth loss due to SNC in 10-70 year-old Douglas-fir in the Oregon Coast Range is estimated at more than 190 million board feet per year. SNC also alters wood properties which can lower the value of certain lumber products, hinder the development of stand structure and wildlife habitat, limit stand management options, and increase the risk of catastrophic fire. The disease is present wherever Douglas-fir grows but has become particularly damaging to Douglas-fir forests on the western slopes of the Oregon Coast Range.

The 2016 SNC aerial survey was conducted in May of this year to detect and map the distribution of SNC damage (Figure 29). The 2016 survey covered 7.2 million acres in the Coast Range, and recorded 546,244 acres of Douglas-fir forest presenting SNC symptoms.

Danny Norlander, ODF

Figure 29. *SNC appears as yellow/brown needles in April and May. Dark green conifers in the photo are hemlock and*

Most damage occurred within 18 miles of the coast, although damage extended 28 miles inland along the Highway 20 corridor (Figure 30, next page).

In 2016, as in two previous years, the survey was extended south through Curry County to the California border even though few symptoms typically are observed south of Port-Orford. In Curry County only 1,276 acres, with symptoms were detected, most of them in the Port Orford area.

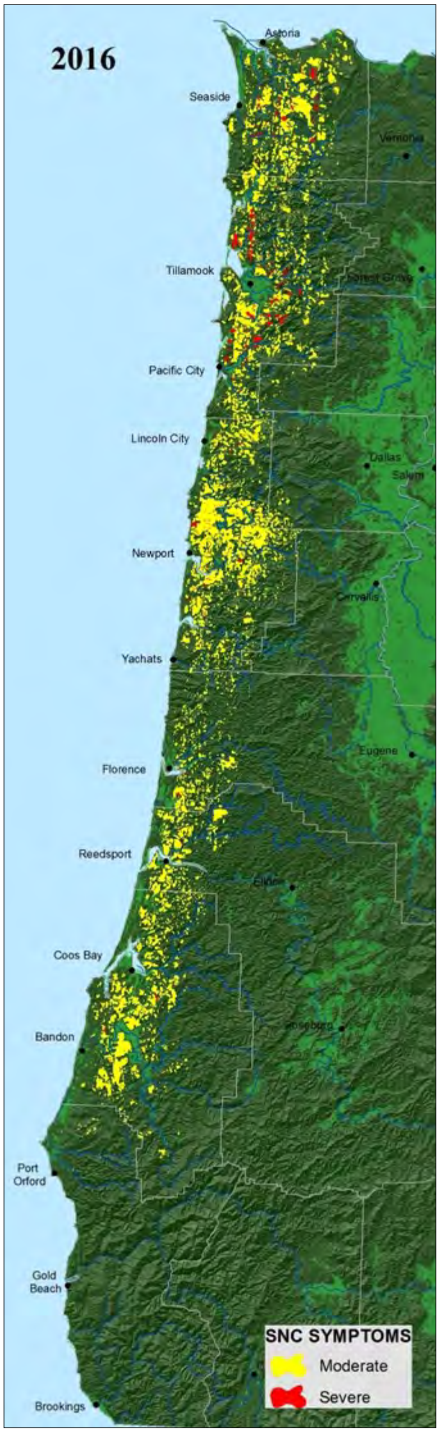


Figure 30. *Areas of Douglas-fir forest with symptoms of SNC detected in 2016. Data from SNC aerial survey.*

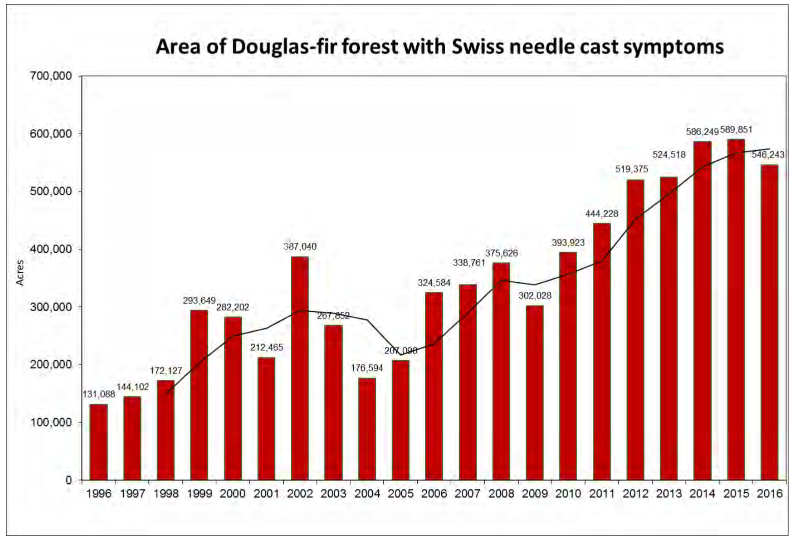


Figure 31. *Area of Douglas-fir forests in western Oregon with symptoms of SNC detected during aerial surveys. Data from SNC aerial surveys.*

Figure 31 shows the trend in damage from 1996 through 2016. The survey showed a slight decrease in the area of forest with symptoms of SNC compared to the previous two years.

In the 2016 survey of the Cascades Range (Lane, Linn, Marion, and Clackamas Counties), 2,240 acres of moderate SNC symptoms were detected. A more systematic survey was flown in 2016 than in 2015, in the Cascades Range in late May.

The SNC aerial survey provides a conservative estimate of damage because observers can map only those areas where disease symptoms have developed enough to be visible from the air. SNC occurs throughout western Oregon but often is not severe enough to enable aerial detection. The aerial survey depicts the extent of moderate to severe damage, documents trends over time, and establishes a zone in which forest managers should account for the effects of the disease.

SNC maps, GIS data and more info at:
http://tinyurl.com/odf-foresthealth
http://sncc.forestry.oregonstate.edu

Web Blight of Western Oregon Conifers

Web blight, caused by a *Rhizoctonia*-like fungus, has been known for over a decade as a disease of Christmas trees (Douglas-fir and true firs) and occasionally dense natural stands with very restricted air flow. Infected needles turn brown and hang from branches long after they have died, bound there by very fine fungal webbing (Figure 32).

Alan Kanasie, ODF

Jared Leboldus, OSU

Figure 32. *Web blight affecting Douglas-fir (left) and western hemlock (right).*

Symptoms first become visible in late winter, are most prevalent in the lower crown, and give the appearance of moving upward in the tree crown as the season progresses to spring. In 2015 symptoms were widespread and obvious on native Douglas-fir and western hemlock in many areas of western Oregon, especially the central Coast Range. In the Cascade Range, similar symptoms were found on mature western hemlock. In some cases, damage was severe, with defoliation of most of the tree crown.

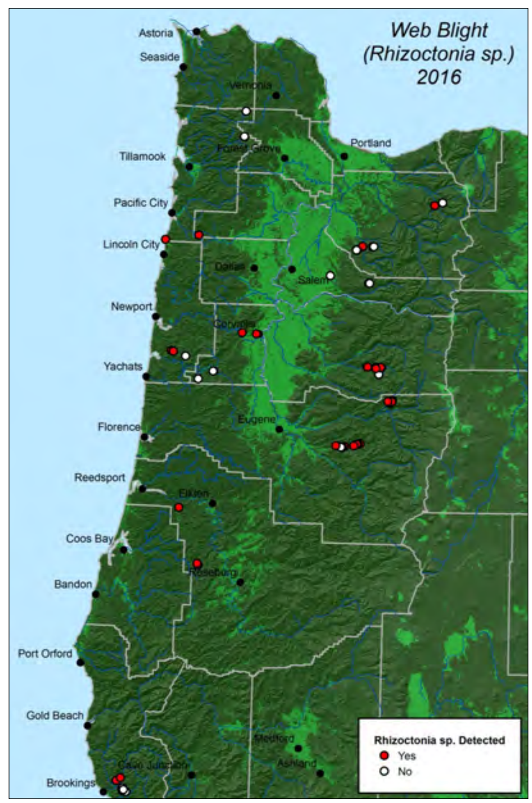


Figure 33. *Web blight locations detected by OSU, ODF and USFS survey in 2016.*

Work continued on this new foliage disease of Douglas-fir and *Phytophthora* needle cast in western Oregon in 2016. Oregon State University, ODF, and USDA Forest Service conducted a survey to determine the geographic range and local incidence of web blight and *Phytopthora* needle cast in west side conifers. Additionally, the survey determined the host range of the needle diseases in west side conifer forests. In 2016, symptoms were reported throughout the west side, but were less severe on Douglas-fir. Web blight was found from Coos County to the northern end of the state (Figure 33). Web blight was also reported on Sitka spruce and mountain hemlock.

Phytophthora Needle Cast of Douglas-fir

***Phytophthora* needle cast** of Douglas-fir, caused by *Phytophthora pluvialis,* was first recognized in New Zealand in 2012. In 2014, Oregon State University confirmed the pathogenicity of *P. pluvialis* on Douglas-fir in Oregon.

Alan Kanaskie, ODF

Figure 34. *Yellowing needles (left) and needle cast on lower branched (right) of Douglas-fir infested by* P. pluvialis.

The signs and symptoms of *Phytophthora* needle cast differ from web blight in that needles infected with *P. pluvialis* are shed quickly, often while still green or slightly yellow (Figure 34). The field symptom of bare lower branches often is coupled with abundant green or yellow needles covering the ground beneath the tree.

In 2016, symptoms associated with *P. pluvialis* were observed less throughout Oregon than in 2014 and 2015 during the collaborative survey (Figure 35). The survey will continue in 2017 to determine the incidence of *P. pluvialis* on the west side.

Laboratory testing was performed comparing *P. pluvialis* isolates from Oregon and New Zealand. Based on molecular results, *P. pluvialis* appears to be native to western Oregon forests.

Figure 35. Phytophthora *needle cast locations detected by OSU, ODF, USFS survey in 2016.*

Incense Cedar Canker

Incense cedar canker continued to be highly noticeable for the third consecutive year on incense cedar throughout the Willamette Valley. Branch "flagging" (red-brown dead foliage on branches) typically begins in the lower crown and progresses upward over a period of years, often resulting in trees with very sparse ragged crowns (Figure 36).

Continued work by the USDA-Agricultural Research Service Horticultural Crops Research Laboratory in Corvallis consistently found *Phaeobotryon cupressi* on branch canker samples from the Willamette Valley. Canker symptoms appeared more quickly on branches during warmer summer weather than in cool spring and fall weather. This pathogen was previously reported once on Rocky Mountain Juniper in Kansas and originally described as a pathogen of Mediterranean cypress in Iran.

Alan Kanaskie, ODF

Figure 36. *Incense cedar canker causes branch flagging and dieback.*

Western Redcedar Decline in Willamette Valley

Brandy Saffell, OSU

Figure 37. *Unusual Western redcedar damage showing live lower crown but dead upper crown.*

Unusual **western red cedar mortality** has been observed in the northern regions of the Willamette Valley and foothills of the Cascades Mountains. Mature trees are dying without a clear pathogen or insect cause (Figure 37).

Currently, no mortality agent has been identified, but it appears to be related to site conditions and recent drought. In several cases we surmised drought was the most likely factor, in other locations, this is not as clear. Some key pathogens detected such as *Phytophthora* species were not detected following laboratory testing. The situation will continue to be monitored in the hopes that as the drought abates tree mortality will cease.

Black Stain Root Disease

Black stain root disease is caused by a tree-killing vascular wilt-type fungus (*Leptographium wageneri)*, transmitted by root feeding bark beetles and weevils. The fungus can also spread tree-to-tree by root contact. It occurs throughout Oregon and causes damage in the Douglas-fir forests of western Oregon and in ponderosa pine forests of eastern Oregon.

Sarah Navarro, ODF

Figure 38. *Symptomatic crowns of Douglas-fir infected with black stain*

The most severe damage occurs in young (10-30 year old) Douglas-fir plantations in the Coast Range (Figure 38). Disease incidence has been positively correlated with management activities that damage or stress trees, such as pre-commercial thinning, soil disturbance, and roadside brushing (Figure 39). These activities attract and favor an increase in populations of the insect vectors.

Observations during 2014 and 2015 suggest that the disease may be increasing in several parts of the Oregon Coast Range. Surveys were conducted in northern and southern portions of the Coast Range to determine the disease severity and distribution in young stands, 2 to 6 years after planting. Black stain root disease was detected in all surveyed stands, however, the threat of this disease to young stands still needs to be evaluated.

Alan Kanaskie, ODF

Sarah Navarro, ODF

Figure 39. *Cross section of a Douglas-fir seedling reveals the presence of black stain root disease (left). Black streaks indicate where the pathogen has colonized the tree's water conducting sapwood (right).*

Young Conifer Mortality

The majority of mortality in young conifers detected in this special survey is caused by black bears peeling back the bark of trees. Mortality of young conifers continues to be a significant source of damage on forest lands throughout northwest Oregon. However mortality levels estimated during the 2016 survey were significantly lower than those seen in 2015 and slightly lower than the 10-year average. The estimated area containing mortality in 2016 was approximately 18,200 acres, down from 37,300 acres in the previous year and below the 10-year average of 19,950 acres (Figure 40). The estimated number of dead trees decreased across all ownerships but remained above the 10-year average. The decrease in number of dead trees coupled with a larger decrease in area indicates intensified concentration of mortality in the polygons mapped but an overall decrease in landscape-level impact.

When the proportions of damage across ownerships are considered, there is a trend in more damage occurring on private lands than other ownerships over the last four years. Damage on private ownerships reached its highest point in the past 10 years in 2015, but decreased in 2016. In 2016, 87% of the young conifer mortality (by area) was on private lands, and mortality on each of the other ownerships was around 5%. An estimated 6 dead trees per acre were mapped within polygons in 2016, which is slightly above the average of 5.8 trees per acre.

Much of the decrease in area with young conifer mortality from 2015 to 2016 was due to a drop in mortality in Columbia County. This marked increase then decrease for Columbia County is similar to trends seen in the 2007 to 2008 time frame. Most other counties had decreases in acres with mortality in 2016 relative to 2015.

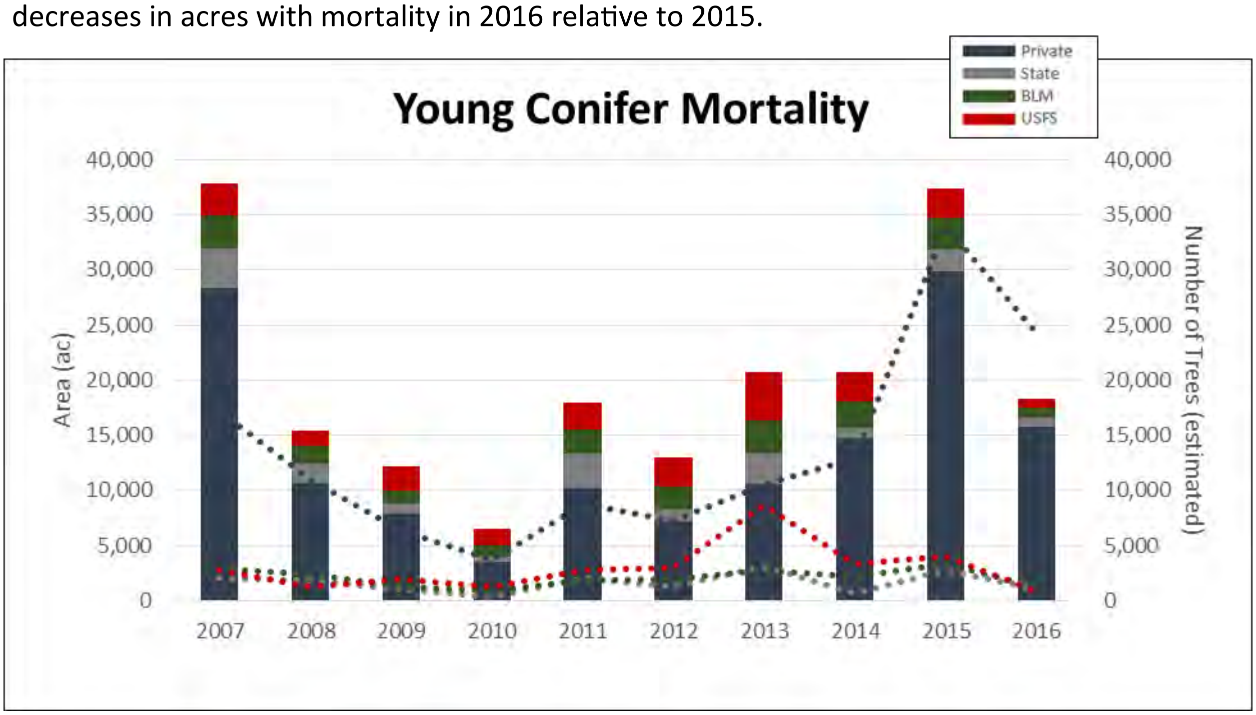


Figure 40. *Ten-year trend of acreage affected by bear and other vertebrates as detected by annual young conifer mortality aerial survey.*

Invasive Species

Gypsy Moth

In September 2015, Oregon Department of Agriculture (ODA) reported capturing two adult **Asian gypsy moths** (AGM; *Lymantria dispar asiatica*) in separate pheromone traps in Forest Park and the St. Johns neighborhood of north Portland as well as one AGM at the Port of Vancouver in Washington. Gypsy moth is a defoliating insect whose larvae feed on several hundred species of trees and shrubs, including conifers. If it were to establish in the western U.S., it has the potential to dramatically change forest management and ecology, leading to increased aerial pesticide use and increased costs for the timber industry. While **European gypsy moth** (EGM; *Lymantria dispar dispar*, Figure 41) is established in the eastern U.S. and is regularly detected in Oregon, the Asian subspecies is not established anywhere in the U.S. and has only been detected in Oregon three times. All AGM and EGM moth eradications in Oregon have been successful since monitoring began in the 1970s.

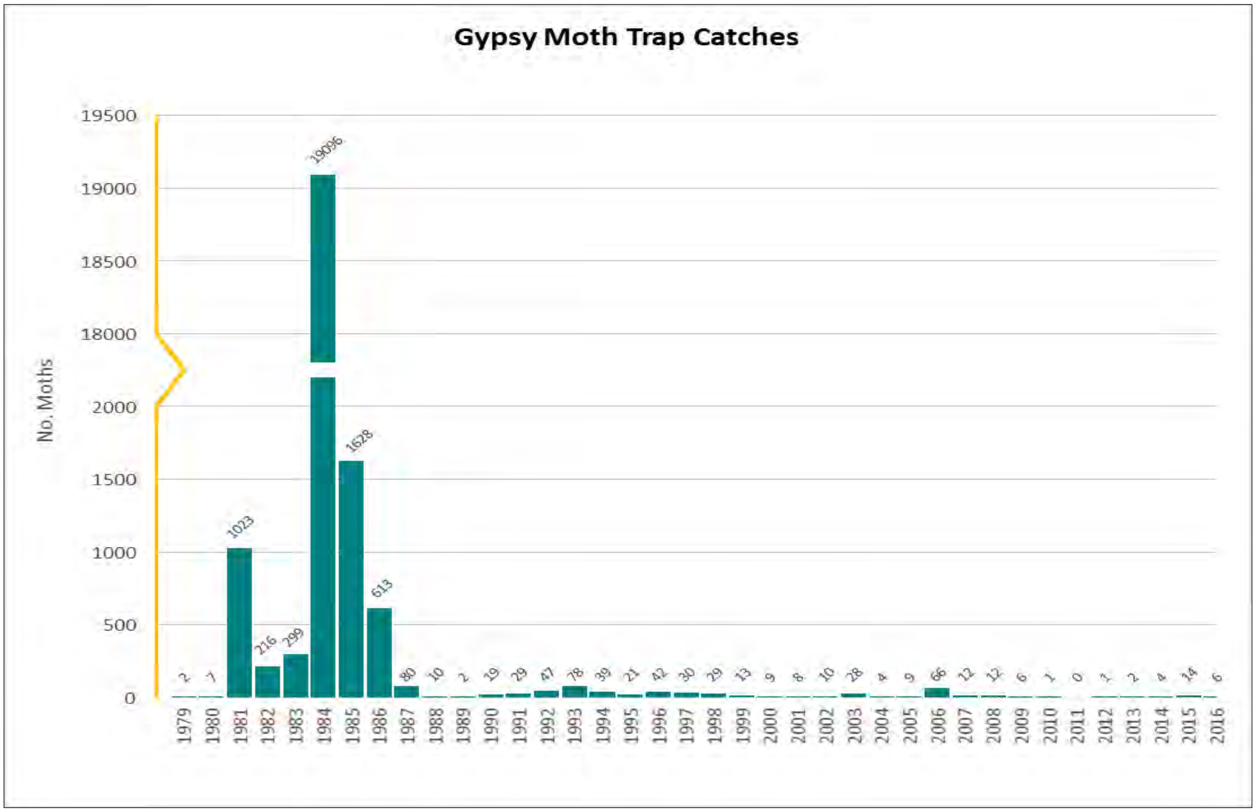
Christine Buhl, ODF

Figure 41. *Male (brown) and female (white) EGM moth adults and eggs. EGM females are flightless but AGM females are able to fly many miles.*

A Technical Working Group consisting of national gypsy moth experts convened in October 2015 and recommended an eradication plan for AGM in north Portland. Acting as the lead agency, ODA requested assistance from ODF as well as other state, federal, and local agencies; non-profit groups; universities; and the public. From October 2015 to April 2016, ODF staff participated in numerous planning meetings, two public open houses, trainings for landowners and citizens, as well as incident command training for the interagency response team. An Oregon contractor was selected to aerially apply three treatments of the organic, naturally-occurring biopesticide, Bacillus thuringiensis kurstaki (Btk) on 8,600 acres in north Portland using rotary wing aircraft (Figure 42, next page). Insect and plant phenology were tracked throughout the spring and spraying commenced during ideal weather conditions on April 16-18, April 25-26, and May 1-2. The insecticide treatments targeted early stage larvae. ODA staff monitored over 3,000 pheromone traps in the treatment area between May and September to detect insects that may have escaped the eradication treatments. In October, ODA announced that no gypsy moths were captured from inside the treatment area. While the treatments appeared to be successful, two more years of negative trap catches must be attained before the treatment area can be declared free of AGM.

ODA staff placed approximately 17,000 gypsy moth traps across the state in 2016. Six EGM were captured: four near Grants Pass and two near Vida. EGM has been captured for four consecutive years at the Grants Pass site. The Vida site is a new detection of EGM in the state. EGM originated from populations in the eastern U.S. and are less risky than AGM. There are no planned eradication treatments for these sites at this time. ODA, ODF, USFS and other partners will continue intense surveillance of these sites in 2017.

More info on gypsy moth at http://tinyurl.com/odf-foresthealth



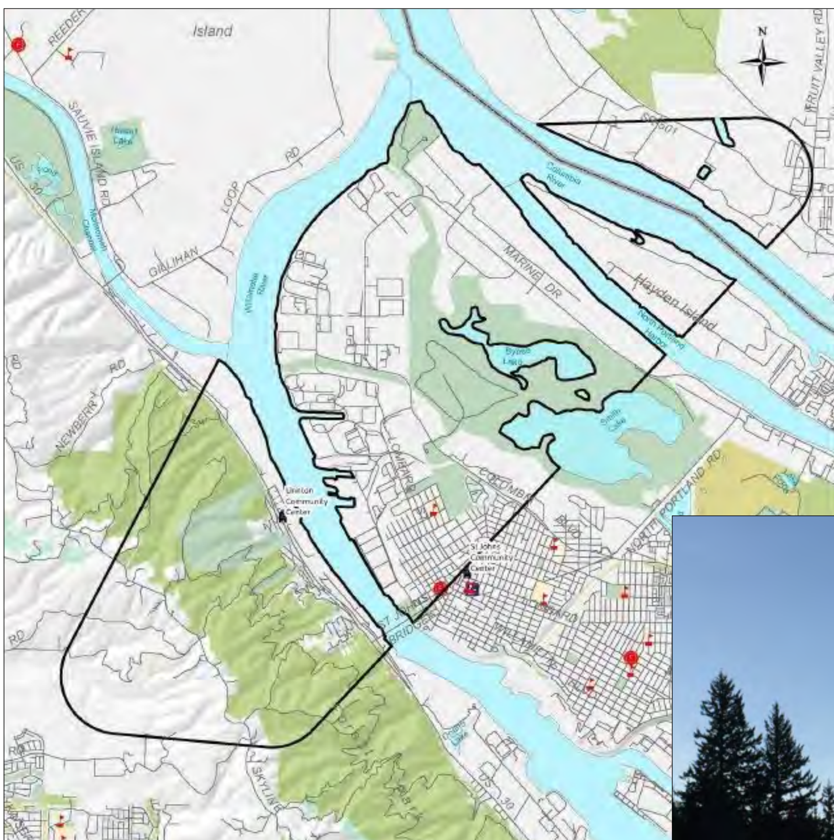
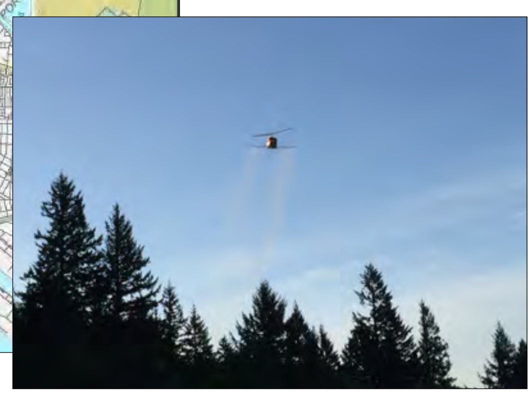
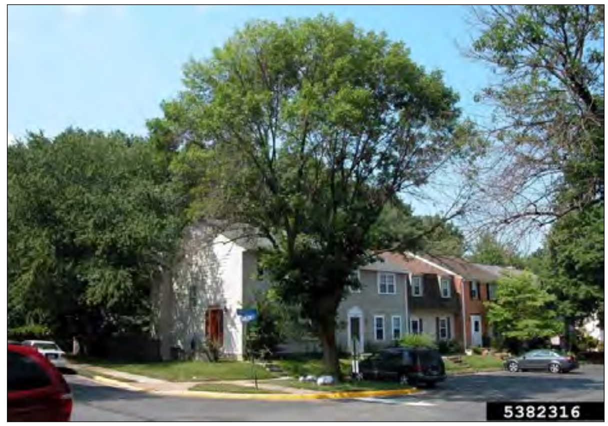


Figure 42. *Historical gypsy moth trap catches in Oregon (top), data from ODA. Map of Asian and European gypsy moth treatment area in Portland metropolitan area (left) with inset of helicopter applying an organic formulation of the naturally-occurring bacteria Bacillus thuringiensis kurstaki*.



Emerald Ash Borer

Emerald Ash Borer (EAB; *Agrilus planipennis*) is an exotic metallic wood boring insect from Asia that was introduced accidentally on wood pallets in the mid-1990s and reported killing ash in 2002 in Detroit, MI. EAB threatens all 16 ash species (*Fraxinus* spp.) in North America (Figure 43), including the only ash species native to Oregon, *F. latifolia*, as well as ash trees native to Europe. This insect has now spread to 25 states and has killed over 100 million ash trees despite monumental eradication, control and outreach efforts. Although the insect disperses naturally by flying up to 12 miles per year, the primary long-distance dispersal mechanism is from human-aided movement of infested firewood. EAB has become the costliest invasive forest insect in the history of the U.S. with over $3.5 billion in control costs, property value depreciations, and timber revenue losses. The closest known EAB infestation to Oregon is Boulder, CO, where officials detected two small populations in September of 2013. In 2016, the USDA Animal and Plant Health Inspection Service selected a nationwide contractor to trap for EAB.



Eric Day-Virginia Tech, Bugwood

Figure 43. *Thin canopy and epicormic shoots in ash trees resulting from EAB attack.*

There were no EAB detected on any of the 400 early detection traps set in Oregon in 2016.

Other Invasive Borers

ODF and ODA received funding from the USFS for an **invasive wood borer monitoring survey** for over 50 species of exotic, invasive woodborers at 12 sites along the Columbia River from Clatskanie to The Dalles. Washington Department of Natural Resources assisted in-kind at one site near Longview, WA. At each site, seven different pheromone lures and tree baits were used to attract and trap wood boring insects (Figure 44). Sites were visited every three weeks during the season and over 750 samples were collected. Entomologists at ODA have begun sorting and identifying wood borer specimens. To date, eleven exotic species and 46 native species have been recorded. Approximately 72% of the wood borer abundance is attributed to exotic species, primarily the ambrosia beetles, *Xyleborinus saxensii* (49%) and *Xyleborus pfeili* (19%). No target exotic wood borers have been encountered in samples thus far. Trapping will continue in 2017 and 2018. The purpose of the project is to test new trap technology and early detection of new pests along a major transportation corridor.


Wyatt Williams, ODF

Figure 44. *Lindgren funnel trap baited with lures for wood boring insects.*

Other Invasive Insects

European greenhouse thrips (EGT, *Heliothrips haemorrhoidalis*, Figure 45) was found damaging salal (*Gaultheria shallon*) along Highway 101 in Coos and Curry counties in April-May. Although this insect originates from South America, it was first described in Europe in 1833 and first observed in the U.S. in 1870. EGT has a worldwide distribution, and in many cases has been transported on greenhouse plants. EGT has piercing/sucking mouthparts and they feed on the underside of plant leaves, causing the leaves to turn silver or white (Figure 45). Although affected salal plants were nearly 100% white, new growth in summer indicates that plants have the ability to rebound from damages caused by EGT. It is unknown what effect, if any, that EGT will have on salal or the surrounding plant community. EGT has been reported anecdotally in the Pacific Northwest on salal and viburnum prior to 2016, but it has not been observed to be established in the state until now. ODF Stewardship Foresters and Forest Health staff conducted surveys of the area and worked in conjunction with ODA Insect Pest Prevention and Management staff to create a pest alert.

Wyatt Williams and Alan Kanaskie, ODF

Figure 45. *European greenhouse thrips (upper) and* damaged salal.

European pine sawfly (EPS, *Neodiprion sertifer*) was reported on mugo pine (*Pinus mugo*) at a private campground in Albany in May 2016. EPS was first reported in the U.S. in 1925 but has not established in the Pacific Northwest. Larvae of this wasp relative feed on pine needles in April and May causing minor defoliation (Figure 46). Feeding rarely causes mortality but does affect the growth and aesthetics of the plant. Preferred hosts include a suite of exotic pines but EPS is also known to feed on ponderosa pine (*P. ponderosa*). A pest alert was issued to local ODF foresters, and surveys by ODF and ODA were conducted in the area. No other populations were found and the mugo pines were treated with an insecticide. Follow-up monitoring of the site will resume in the spring of 2017.

Thomas Shahan, ODA

Figure 46. *European pine sawfly larvae feeding on mugo pine needles.*

Invasive Plants

Invasive forest plants continued to be a top request for assistance by ODF Forest Health staff. ODF Invasive Species staff provided training and landowner technical assistance on common Oregon forest weeds. With specimens and equipment donated by the Department of Botany and Plant Pathology at Oregon State University, ODF initiated its own herbarium to house plant specimens for observations and trainings. Nearly 100 plant species comprise the collection, which accompanies ODF's insect and fungal collections.

In March, ODF hosted the first **English Ivy** Research Forum. Practitioners in English ivy control shared their successes and failures among the meeting participants. Also in March, updates to the ODF State Forests Recreation rule (OAR 629-025-0000 through 629-025-0080) went into effect after the Board of Forestry unanimously approved the changes. Specifically, the updated rule prevents the movement and establishment of noxious weeds by requiring equestrians and hunters to use certified Weed Free Forage (WFF) when on lands administered by ODF (Figure 47). The new rule matches the requirements for WFF on federal lands by the U.S. Forest Service. The state of Oregon maintains a WFF certification program through the ODA.

Wyatt Williams, ODF

Figure 47. *Hay bales can harbor seeds of noxious weeds.*

Vendors and producers of WFF from across the state can be found here:
http://www.oregon.gov/ODA/programs/MarketAccess/MACertification/Pages/WeedFreeForage.aspx

Wyatt Williams, ODF

Figure 48. *Kangaroo apple in flower.*

Finally, a new state record of an exotic plant was made by ODF staff. A landowner near Florence reported an odd looking plant to the local Stewardship forester who then notified the ODF Forest Health Unit. The plant was collected and samples deposited into the Oregon State University Herbarium. **Kangaroo apple** (*Solanum aviculare*) is a member of the nightshade family native to New Zealand and Australia (Figure 48). It is a perennial plant that can grow over 8 feet in height and all plant parts except mature fruit are toxic to mammals. The plant was found within a 60-acre harvest unit on a slash pile that was burned in 2013. There is no indication that the plant will become a nuisance weed, but alerts of its presence were sent to local agencies and the Oregon Department of Agriculture.

Oregon Forest Pest Detector Program

For the third year, ODF Forest Health team members assisted with the Oregon Forest Pest Detector (OFPD) program which is funded by the USDA and coordinated and led by OSU Extension Forestry. This program trains arborists, landscapers, park workers and other professionals to recognize early signs and symptoms of priority invasive forest pests and teaches the basics of invasive species theory and management, pathways of introduction, how to file reports and confidentiality. Using a combination of online modules, face-to-face seminars and field training courses with simulated attacks, over 400 professionals have been trained as “First Detectors” of emerald ash borer, Asian long-horned beetles and Asian gypsy moth (Figure 49). In 2016, 12 OFPD courses were taught and upcoming trainings for 2017 include Corvallis (March 23), Oregon City (March 25), Milwaukie (April 6) and Portland (April 15).

More info at: http://pestdetector.forestry.oregonstate.edu

The OFPD works with the Oregon Invasive Species Council to utilize the mobile-friendly “Oregon Invasives Hotline” online reporting system so that First Detectors can take a picture and log a report of possible invasive species while in the field. These reports are then reviewed by agency experts. The overall goal is to detect key forest invaders early in their invasion establishment when eradication is still feasible.

More info at: https://oregoninvasiveshotline.org

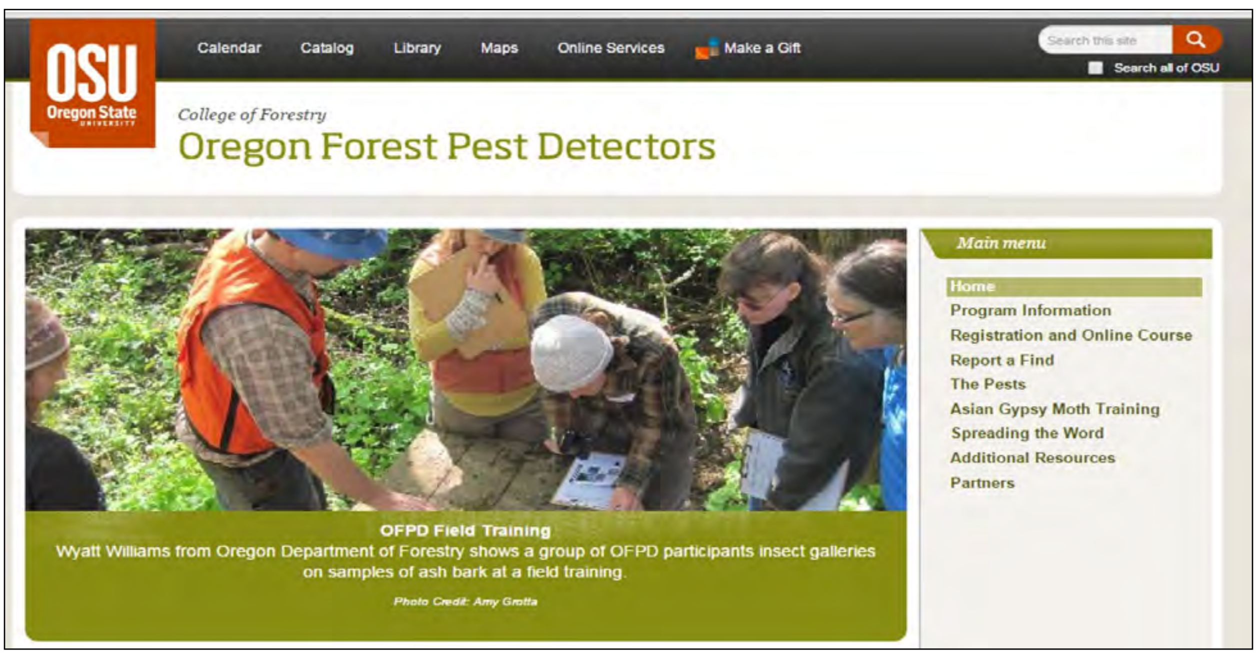


Figure 49. *ODF Invasive Species Specialist, Wyatt Williams, provides training on emerald ash borer to students in the Oregon Forest Pest Detector program.*

Additional Information on Forest Health

Annual aerial detection survey data, maps and GIS shapefiles:

http://www.oregon.gov/odf/privateforests/pages/fhMaps.aspx
http://www.fs.usda.gov/goto/r6/fhp/ads

***Forest Health Highlights* reports for Oregon and Washington:**

http://www.fs.usda.gov/goto/r6/fhp/highlights

Fact *sheets* and other info on forest insects, diseases, weeds, etc.:

http://tinyurl.com/odf-foresthealth
http://tinyurl.com/usfs-fidl
http://www.fs.usda.gov/main/r6/forest-grasslandhealth/insects-diseases

Forest health literature:

Goheen, E.M. and E.A. Willhite. 2006. *Field Guide to the Common Diseases and Insect Pests of Oregon and Washington Conifers*. USDA Forest Service R6-NR-FID-PR-01-06.

Furniss, R.L. and V.M. Carolin. 1977 and 1992. *Western Forest Insects*. USDA Forest Service Miscellaneous Publication No. 1339.

Johnson, W.T. and H.H. Lyon. 1976 and 1988. *Insects that Feed on Trees and Shrubs*. Cornell University Press.

Scharpf, R.F. 1993. *Diseases of Pacific Coast Conifers*. USDA Forest Service Pacific Southwest Research Station. Agriculture Handbook 521.

Sinclair, W.A., H.H. Lyon, and W.T. Johnson. 1987. *Diseases of Trees and Shrubs*. Cornell University Press.

Filip, G.M., Kanaskie, A., Campbell III, A. 2003. *Forest Disease Ecology and Management in Oregon.* Oregon State University, Extension Service.

Emmingham, W.H., Oester, P.T., Fitzgerald, S.A., Filip, G.M. and W.D. Edge. 2005. *Ecology and Management of Eastern Oregon Forests A Comprehensive Manual for Forest Managers* Oregon State University, Extension Service.

Shaw, D.C., Oester, P.T. and G.M. Filip. 2009. *Managing insects and diseases of Oregon conifers*. Oregon State University, Extension Service.

Contacts

For questions about forest health in Oregon please contact :

Oregon Department of Forestry

Forest Health
Oregon Dept. of Forestry
2600 State St
Salem, OR 97310

http://tinyurl.com/odf-foresthealth

Christine Buhl, 503-945-7396, christine.j.buhl@oregon.gov
Alan Kanaskie, 503-945-7397, alan.kanaskie@oregon.gov
Sarah Navarro, 503-945-7394, sarah.navarro@oregon.gov
Wyatt Williams, 503-945-7472, wyatt.williams@oregon.gov
Danny Norlander, 503-945-7395, danny.norlander@oregon.gov

USDA Forest Service

Forest Health Protection
Pacific Northwest Region
1220 SW Third Ave,
Portland, OR 97208

http://www.fs.usda.gov/goto/r6/fhp

Debbie Hollen, 503-808-2340, dahollen@fs.fed.us
Karl Dalla Rosa, 503-808-2913, kdallarosa@fs.fed.us
Iral Ragenovich, 503-808-2915, iragenovich@fs.fed.us
Karen Ripley, 503-808-2674, klripley@fs.fed.us
Greg Filip, 503-808-2997, gmfilip@fs.fed.us
Zack Heath, 503-668-1459, zheath@fs.fed.us

Westside Oregon Service Center
Mount Hood National Forest
16400 Champion Way
Sandy, OR 97055

Beth Willhite, 503-668-1477, bwillhite@fs.fed.us
Kristen Chadwick, 503-668-1474, klchadwick@fs.fed.us
Holly Kearns, 503-668-1475, hkearns@fs.fed.us
Ben Smith, 503-668-1761, bsmith02@fs.fed.us
Justin Hof, 503-668-1646, justinhof@fs.fed.us

Southwest Oregon Service Center
J. Herbert Stone Nursery
2606 Old State Rd
Central Point, OR 97502

Bill Schaupp, 541-858-6125, bschaupp@fs.fed.us
Ellen Goheen, 541-858-6126, egoheen@fs.fed.us
Josh Bronson, 541-858-6126, jjbronson@fs.fed.us
Robert Schroeter, 541-858-6123, rschroeter@fs.fed.us

Central Oregon Service Center
Deschutes National Forest
63095 Deschutes Mkt Rd
Bend, OR 97701

Robbie Flowers, 541-383-5788, robbiewflowers@fs.fed.us
Helen Maffei, 541-383-5591, hmaffei@fs.fed.us
Brent Oblinger, 541-383-5701, boblinger@fs.fed.us
Mike Simpson, 541-383-5575, mlsimpson@fs.fed.us

Blue Mountains Service Center
Forestry Sciences Laboratory
1401 Gekeler Ln
La Grande, OR 97850

Mike Johnson, 541-962-6545, jaymjohnson@fs.fed.us
Lia Spiegel, 541-962-6574, lspiegel@fs.fed.us
Michael McWilliams, 541-962-6544, michaelgmcwilliams@fs.fed.us
Michael Jennings, 541-962-6530, michaeldjennings@fs.fed.us