Forest Health Highlights in Oregon 2017

Oregon Department of Forestry
Forest Health Program

Pacific Northwest Region
Forest Health Protection

for the greatest good

Forest Health Highlights in Oregon 2017

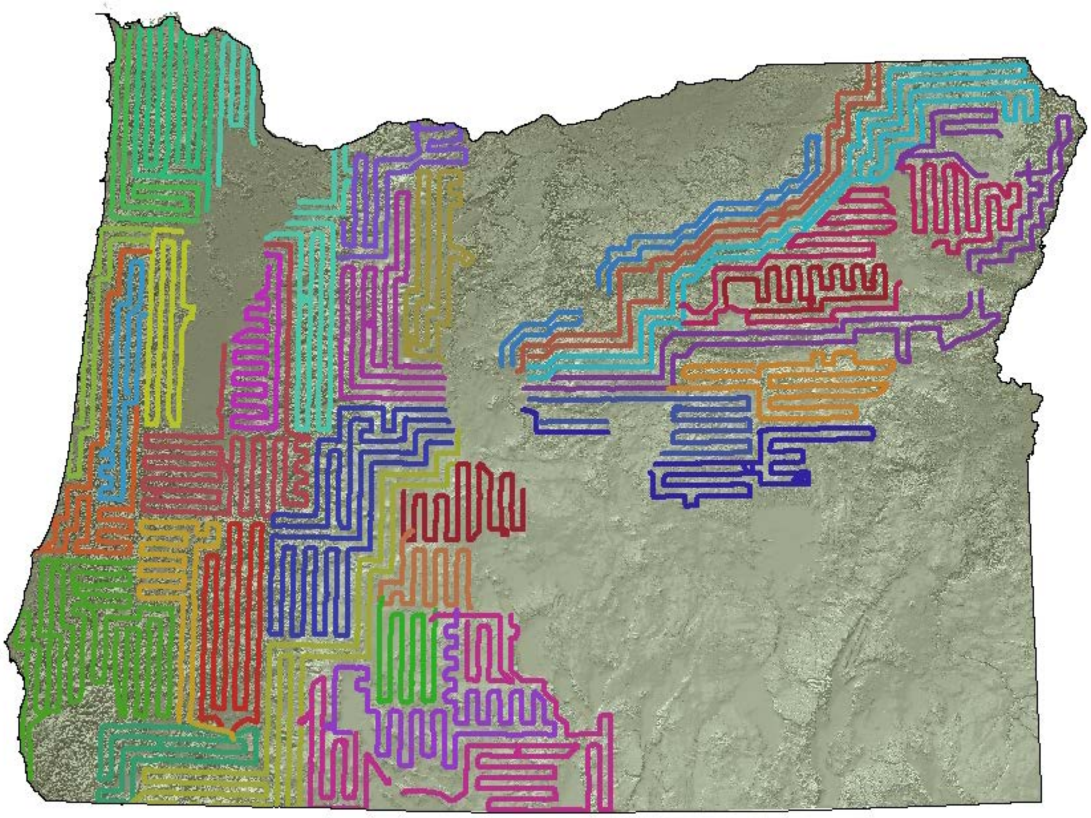
Joint publication contributors:

Christine Buhl[1]
Sarah Navarro[1]
Danny Norlander[1]
Wyatt Williams[1]

Zack Heath[2]
Karen Ripley[2]
Robert Schroeter[2]
Ben Smith[2]

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

Cooperative Aerial Survey: 2017 Flight lines



The aerial survey program is changing! Give us input to better serve your needs.

Front cover image: *Orange hawkweed (*Hieracium aurantiacum*), a European exotic, was first identified in Oregon in 2017 in Clatsop County (Photo by Peter Dziuk).*

Table of Contents

SUMMARY **1**

AERIAL AND GROUND SURVEYS **2**

ABIOTIC STRESSORS **4**

- **Climate and Weather** **4**
- **Drought** **5**
- **Storm Damage** **6**
- **Solar Eclipse** **6**
- **Fire** **7**
- **2017 Fire Map** **8**

YOUNG CONIFER MORTALITY **9**

FOREST INSECTS **10**

- **Insect Damage Maps** **12**
- **Bark Beetles** **13**
  - Bark beetles in Douglas-fir 13
  - Bark beetles in pine 14
  - Bark beetles in true fir 15
- **Woodboring Insects** **15**
- **Defoliators** **17**
- **Sap-sucking Insects** **18**
- **Oregon Bee Project** **19**

FOREST DISEASES **20**

- **Non-native diseases** **20**
  - Sudden Oak Death 20
- **Foliar diseases** **23**
  - Swiss needle cast 23
  - Web blight 25
  - Phytophthora needle cast 25
  - Leaf blight of Pacific madrone 26
- **Root diseases** **26**
- **Other diseases** **27**

INVASIVE SPECIES **28**

- **Invasive Insects** **28**
- **Invasive Plants** **30**
- **Oregon Forest Pest Detector** **31**

FOREST HEALTH RESOURCES **32**

CONTACTS **33**

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 redcedar, western hemlock, lodgepole and ponderosa pine among others. The most abundant hardwoods are bigleaf maple, red alder, Oregon white oak, and cottonwood.

This report highlights major agents of damage or mortality in Oregon forests over the past year as well as updates on chronic issues. Much of the data is obtained from aerial surveys, which provide a snapshot in time of damage visible from the air. Symptoms of some forest stressors may not be diagnosed from the air due to timing of surveys or a lack of externally visible signatures but information for these agents is provided, where possible, by ground surveys. Complexes of multiple stressors are common, and determining the primary cause of tree mortality from aerial surveys may not be possible. Totals of damage represent estimated volume of acres *with* damage rather than total acres *of* damage. Volume of damage, causal agents and geolocations reported here and in the raw data are estimates and should not be used exclusively to guide management.

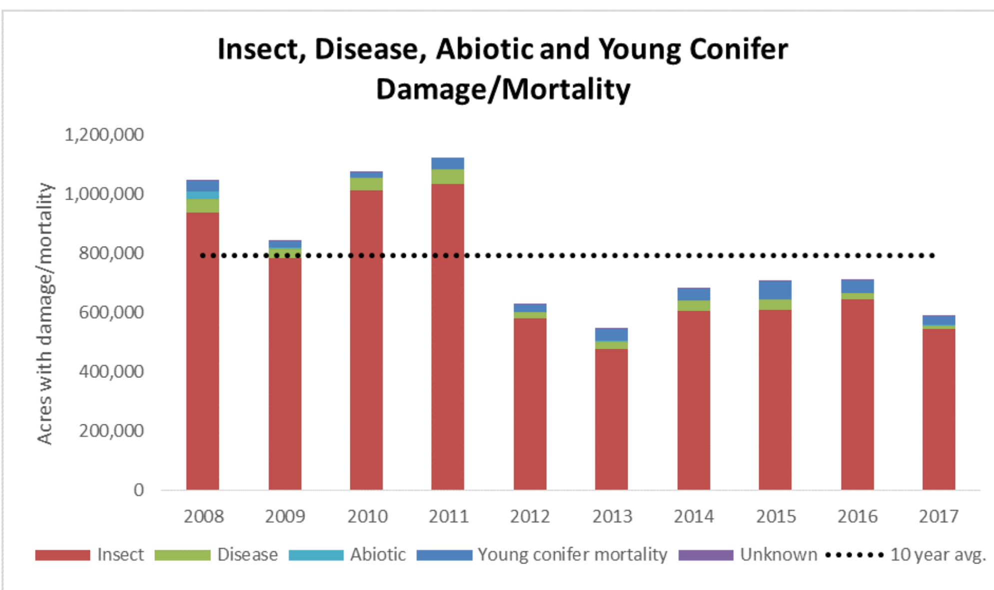


Figure 1 Acres with tree damage and mortality by causal agent.

Of the 28 million total forested acres aerially surveyed in 2017, an **estimated 58,000 acres contained damage and another 532,500 acres contained mortality from insects, diseases, vertebrate animals and abiotic events** that could be observed (Fig. 1).

Aerial and Ground Surveys

A corner stone of monitoring the health of Oregon's forests is an annual aerial survey of visible damage. This consists of a cooperative program between the Oregon Department of Forestry and the USDA Forest Service. The annual survey has been taking place since 1947 and has evolved over the years into the reliably qualitative survey that is conducted today. Each year the program conducts several different surveys to achieve different goals from trend monitoring to mapping and locating invasive forest health issues across all ownerships (Figs. 2 and 3). The primary survey is the general overview survey covering a majority of the forested lands of the state at roughly 35 million acres each year. Additional surveys include those for young conifer mortality (damage from vertebrates and other agents), Swiss needle cast survey along the coast which is funded through the Swiss Needle Cast Cooperative at Oregon State University (OSU), and seasonal surveys for sudden oak death in Curry County. Periodic surveys have been conducted for oak looper in the Willamette Valley, gorse along the southern Oregon coast, Pandora moth in central Oregon, and winter storm damage in various locations.

Flight hours	**General overview**	**SOD-Helicopter**	**Young conifer mortality**	**Total**
ODF	19.4	7.1	33.6	60.0
USFS	70.9			70.9
Total	90.3	7.1	33.6	131.0

Figure 2 Total hours of survey time on the general and special surveys.

The 2017 survey season started off well but was delayed due to remnant snow at higher elevations and subsequent smoke and fire activity throughout the region. In total, approximately 35.4 million acres were surveyed in the general overview survey. For the first time since 1996, the Swiss needle cast (SNC) special survey was not flown and it was determined that a biennial survey effort would meet the user needs. The SNC survey will be conducted in 2018 and in even years thereafter.

Aerial survey and monitoring remains essential to sudden oak death (SOD) eradication and slow the spread work. Summer 2017 SOD survey efforts were limited due to fire, smoke, and logistical issues but the quarantine area was surveyed three times during the year for a total of approximately 375,000 acres of intense scrutiny from a helicopter.

Damage from all agents in the 2017 aerial survey was lower than the 10-year average by almost 200,000 acres. Most of the damage was due to bark beetles seen in the eastern two thirds of the state. All categories of damage type (e.g., bark beetle-caused mortality, insect defoliation, etc.) were down for the year. It is important to note that the metric measured is acres *with* (not of) damage and that not all the trees in the indicated areas will experience mortality or defoliation. As is normally seen, the majority of the area with damage is on federal lands, followed by industrial ownership, small non-industrial, state, and tribal lands.

As part of a national program that conducts aerial surveys, future survey efforts will be conducted utilizing a new data collection system and a new metric of observation. This new system should provide the end-user with reliable data that can more easily be utilized and compared across ecotypes and management strategies. If you would like to discuss this new system, its use, the metrics involved, or the process as a whole, please contact the ODF or USFS aerial survey staff.

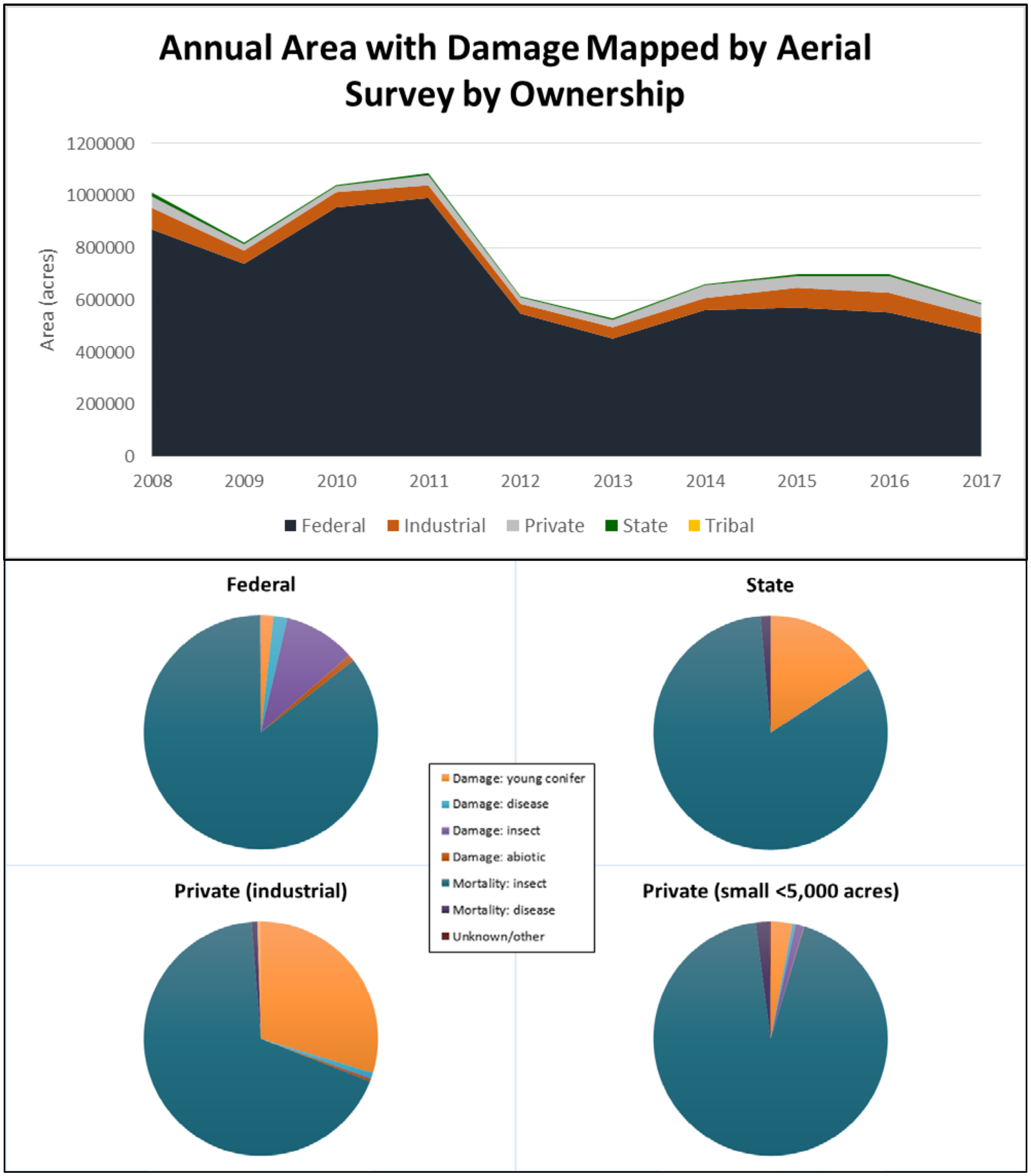


Figure 3 Proportion of forested acres with damage for each ownership from 2008-2017 (top) and breakouts for type of damage for each ownership in 2017 (bottom).

Abiotic Stressors

Climate and Weather

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 weather and the variable ecoregions found in the state.

Much of the state experienced closer to average rainfall and the snowpack from winter 2016-17 recharged many waterways (Fig. 4). Despite this, temperatures in many areas were still above normal and summer 2017 ended with an extended hot and dry period and continued into a drier than usual winter of 2017-18.

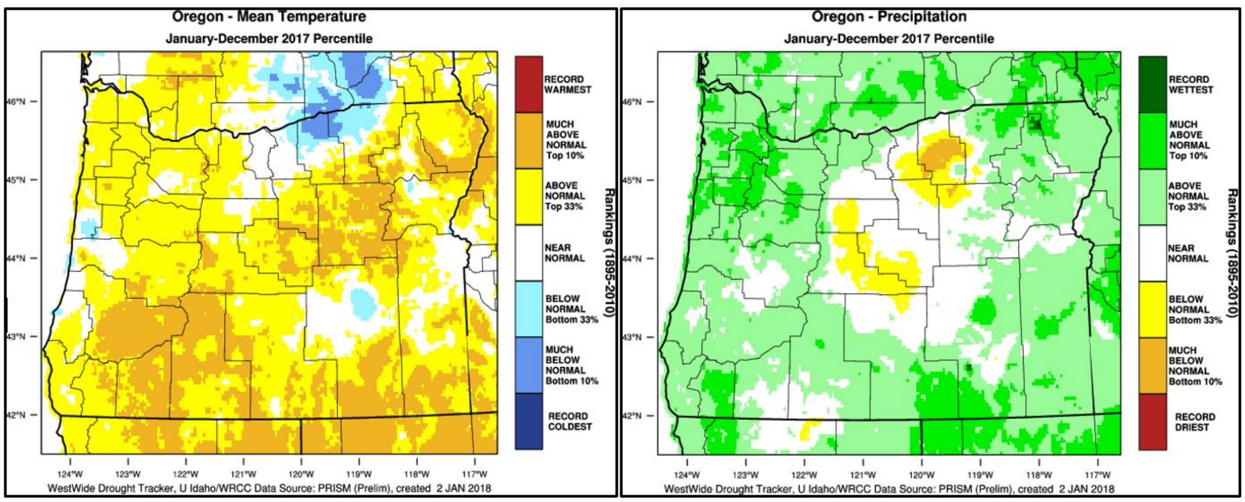


Figure 4 Mean statewide temperature (left) and precipitation (right) for 2017.

Some trees continue to experience fallout from our last drought period, which peaked from 2013 through 2015, although many areas have rebounded. In particular, Douglas-fir and true fir in the Willamette Valley, and pines on poor sites in eastern Oregon are still experiencing drought-initiated mortality. The duration of drought may be finite but the effects on trees are long-lasting as prior extreme conditions continue to kill trees that previously were thriving.

Therefore it is imperative that current and future drought conditions are accounted for when deciding on density levels, timing and intensity of thinning. Contact forestry professionals in your area to obtain technical advice and guidance on stocking and thinning:

OSU Forestry Extension Agent directory: http://extensionweb.forestry.oregonstate.edu/directory

ODF Stewardship Forester directory: http://www.oregon.gov/ODF/Working/Pages/FindAForester.aspx

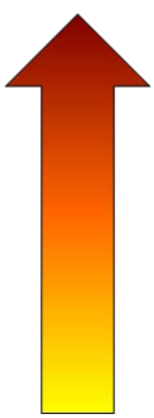
USFS directory (federal clients only):
https://www.fs.usda.gov/detail/r6/forest-grasslandhealth/insects-diseases/?cid=stelprdb5287909

Drought

Drought can cause collapse of vascular tissues, atrophied roots and fewer resources to be allocated to growth, and then to defense. ‘Blind attacks’ or bark beetle attacks that don’t induce sap flow for defense in trees can make identifying beetle infestation difficult in drought-stressed trees. Sap is an important physical and chemical barrier to bark beetles and vectored fungi. Diagnostic indicators of drought include diminished physical features or growth due to an inability to access or absorb water (Fig. 5). Damage to roots from other factors such as waterlogging or compaction may often present similar symptoms.

Drought factsheet: http://tinyurl.com/odf-foresthealth

Figure 5 Drought may result in a thinning canopy or stress cones (left; C. Buhl, ODF), flagged branches (center; C. Buhl, ODF) and/or topkill (right; B. Withrow-Robinson, OSU).



Susceptibility to drought

Douglas-fir

Western redcedar

Grand and noble fir

Ponderosa pine

Red alder

Storm Damage

Winter storms of 2016-17 brought strong, cold winds as well as ice and snow. Lane County, the Columbia River Gorge and coastal areas were hardest hit by blowdown and breakage events (Fig. 6). Breakage creates openings for fungal spores and produces slash debris that may be attractive to some pine-infesting bark beetles. Blowdown of >8" dbh Douglas-fir is also attractive to Douglas-fir beetles and may present an opportunity for infestation if it is not removed or treated with MCH by April.

Storms and Forest Health factsheet: http://tinyurl.com/odf-foresthealth

Figure 6 Winter storm blowdown near Veneta (left; Roseburg For. Prod. Co.) and in the north coast (right; C. Buhl, ODF).

Solar Eclipse

In 2017 a total solar eclipse traversed the center of the state and brought many visitors to Oregon, which raised concerns over heightened fire risks particularly in recreation areas. ODF, Oregon Department of Transportation and other state agencies played a role in fire prevention and suppression efforts, which resulted in lower than average fire starts over the weekend of the eclipse.

Figure 7 2017 total solar eclipse in Oregon (C. Buhl, ODF).

Fire

Figure 8 Horse Prairie fire that burned over 16,000 acres in southwest Oregon (ODF Protection).

Across all ownerships in Oregon there were over 2,000 fires reported, which burned an estimated 644,000 acres in 2017 (Figs. 8-11). This was about 30% more than the 10-year average for acres annually damaged by fire. Remote locations and rugged terrain made initial attack and containment more difficult, which contributed to more acres burned. Fires caused by lightning increased 3-fold relative to 2016 and were slightly higher in number than for human caused fires. However human negligence continues to be a problem as seen in the ignition of the Eagle Creek fires from fireworks. The immediate and coordinated response efforts among ODF, USFS, Oregon Department of Corrections fire crews, tribes, local fire districts and many other cooperators and contractors kept 94% of all wildfires on lands protected by the state to 10 acres or less. The long duration of many of this year's large wildfires, however, contributed to significantly higher suppression costs, estimated at $453 million statewide. The fire season was extended for many personnel that assisted with late season fires in California.

Figure 9 Mop-up crew putting out the last of the Horse Prairie fire (ODF Protection).

Fire damage is a common stressor that predisposes trees to mortality from insects such as bark beetles. Timely removal of living, fire-damaged trees can prevent subsequent beetle infestation and outbreak. Trees damaged by fire that survive are less tolerant of beetle and other insect attacks for years after a fire. These trees found around fire perimeters should be removed to prevent insect outbreaks.

2017 Fire Map

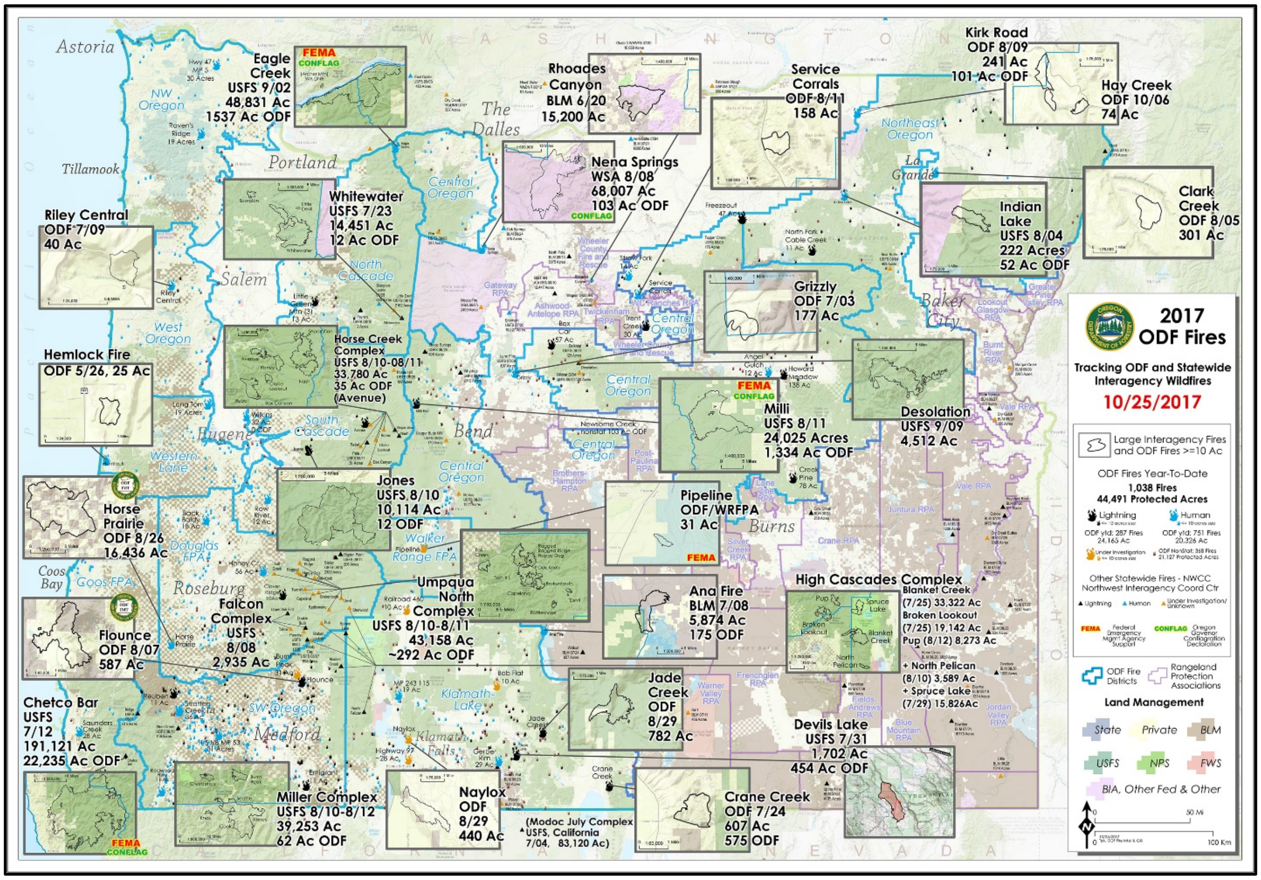


Figure 3 Stats for major fires in 2017 in Oregon.

Figure 11 Chetco Bar fire crew renewing fireline from 2002 Biscuit fire (K. Ripley, USFS).

Young Conifer Mortality

Since 1988 annual aerial surveys on the west side of the state have focused on issues related to younger conifers. These include bark peeling by black bears, drought stress, and root disease among others. In the 2017 aerial survey, observers mapped just under 27,700 acres. This was below the current 10-year average of 30,650 acres. Damage to young conifers that is visible from the air (Fig. 12) tends to follow a cyclical trend that peaks roughly every ten years. Although only speculative, young conifer damage is higher following drought years, and then declines. Peaks were observed in 2003, 2007, and 2015; all years that followed drought periods. Damage decreased on federal and non-industrial private lands but stayed the same as was observed in 2016 on industrial and state lands (Fig. 13). Damage tends to be higher on industrial relative to state and federal lands due to management objectives that favor younger stands and a higher proportion of ownership of these younger stands. Additionally, industrial ownerships make up a larger proportion of western Oregon lands than state or federal ownerships. There has been anecdotal evidence that the area impacted by black stain root disease has been increasing in recent years. If true, this may increase estimates of young conifer mortality. Future field surveys and research may shed some light on this interaction and provide guidance on management strategies to reduce mortality in the young stand.

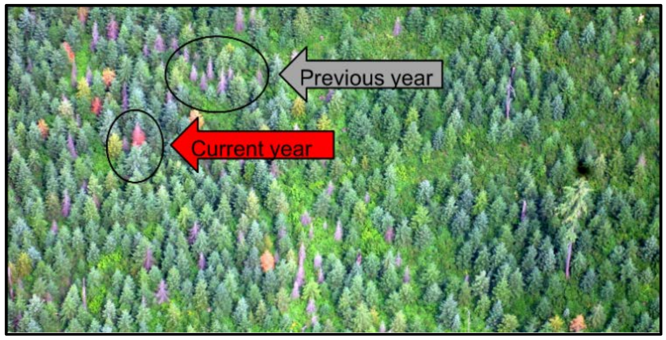


Figure 42 Aerial view of young conifer mortality.

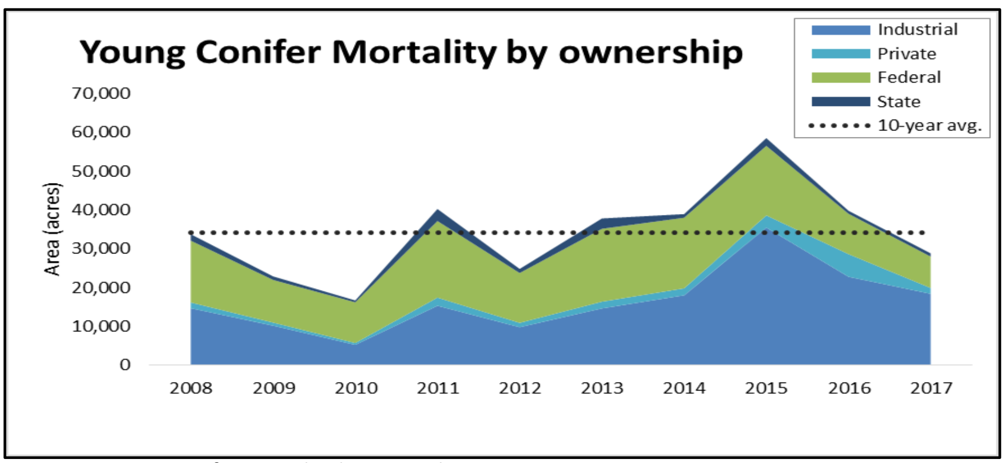


Figure 13 Young conifer mortality by ownership.

So why the change in nomenclature from 'bear damage' to 'young conifer mortality'? Historically, most of the damage associated with young conifers was attributed to black bears. It has become evident that there are more agents at work in these dynamic stands and that attributing all the damage to black bears may not be inaccurate. This shift in language will hopefully demonstrate that young forest stand health has many different considerations that need to be addressed, and we should not focus only on animal damage. Amounts of younger conifer mortality may shift, just as the climate that they are growing in is shifting, which may predispose trees to increased drought stress and historically less important primary and secondary insects and diseases. Contact the ODF or USFS aerial survey specialists with any comments or questions relating to the aerial survey of young conifer mortality.

Forest Insects

In 2017, Oregon statewide aerial surveys detected approximately 544,500 acres with damage or mortality from forest insects (Figs. 14-16), which represents over 90% of the total acres of forest damage detected in aerial surveys. Bark beetles caused the majority of damage, followed by sap-sucking insects (which are a chronic problem in some areas), woodboring insects, then defoliators (which are often cyclical). Damage from each of these groups decreased from surveys in 2016 and total damage has remained below the 10-year average for the past six years.

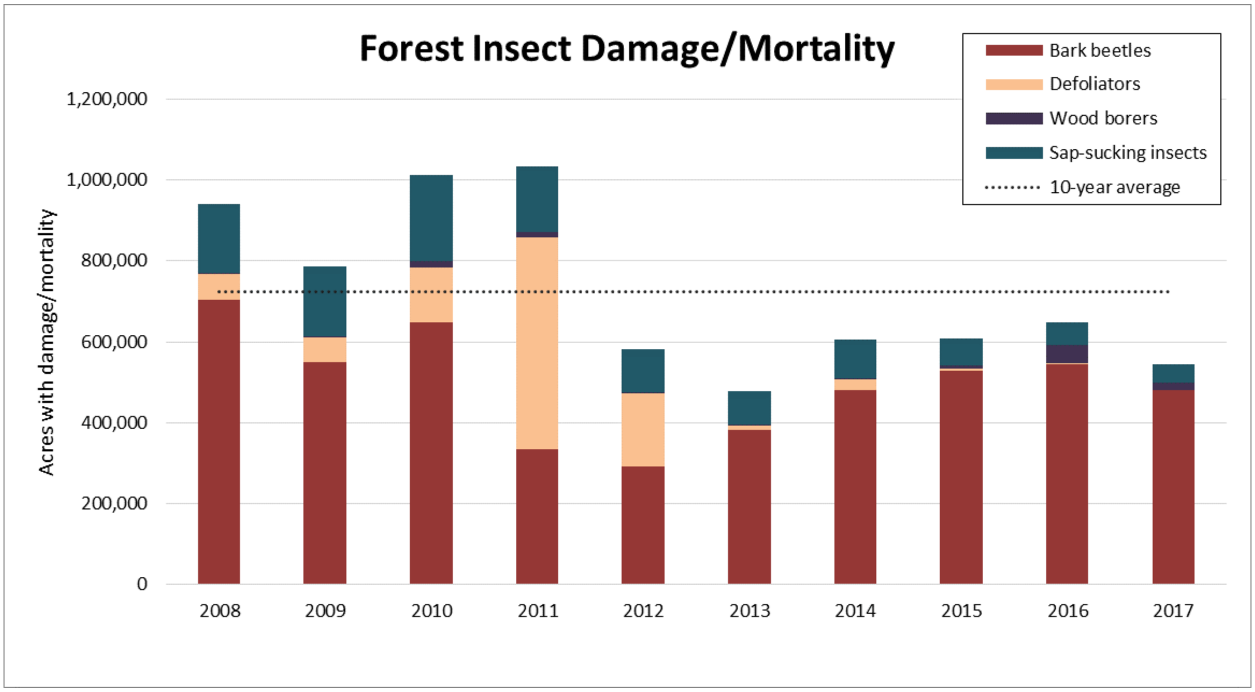


Figure 54 10-year trend of damage and mortality from insects by feeding guild.

Currently the most damaging insects are **bark beetles** including Douglas-fir beetle, fir engraver, *Ips* beetles, mountain and western pine beetles - all of which contributed to a combined mortality in conifers across about 479,000 acres. Within the **wood boring beetles** group, the primary mortality agent in forest trees is the flatheaded fir borer, which killed Douglas-fir trees across 17,400 acres. Major **sap-sucking insect** pests in forests include black pineleaf scale and balsam woolly adelgid, which are chronic in some areas and caused damage and mortality on over 46,700 acres. Forest **defoliators** in Oregon have cyclical outbreaks and have recently been at a low. Defoliators contributed to damage across 1,300 acres, which was attributed mostly to tent caterpillar in alder and don't include a recent spike in Pandora moth.

Management techniques for many of our forest insect pests, bark beetles in particular, are limited to preventative measures. When trees are healthy they can defend themselves but under stressful situations or during outbreaks that resiliency is reduced. Events that create stressed trees such as drought, fire, mechanical damage from operations, storm breakage and blowdown, etc. can reduce resistance and tolerance of insect attack even in previously healthy trees. It is essential to be aware of the major pests of your tree species, and basic prevention/mitigation measures should be built into long-term stand management decisions.

MAJOR FOREST PESTS IN OREGON BY HOST:

What's my host species? Oregon Tree ID: http://oregonstate.edu/trees/name_common.html
Insect and Control and Management factsheets: http://tinyurl.com/odf-foresthealth

Douglas-fir
- Douglas-fir beetle
- Flatheaded fir borer
- Douglas-fir tussock moth
- Western spruce budworm

True fir
- Fir engraver
- Western spruce budworm
- Douglas-fir tussock moth
- Balsam woolly adelgid

Pine
- *Ips* beetles
- Western pine beetle (ponderosa only)
- Mountain pine beetle
- Pine butterfly
- Black pineleaf scale

Spruce
- Spruce beetle
- Spruce aphid
- Western spruce budworm

Larch
- Larch casebearer

Major management tools that promote tree resilience to most pests include:

1. Timely and adequate pre-commercial thinning
2. Moving away from planting some species or cultivars in areas that are no longer conducive to their growth needs
3. Removal of stressed, damaged or less vigorous trees. In *some* cases removal of trees still infested with bark beetles (without exit holes and often still green) can reduce outbreak intensity.

Incentive programs and grants to offset costs of preventative management are available to landowners. Contact your ODF, OSU extension, or Natural Resources Conservation Service office for more details.

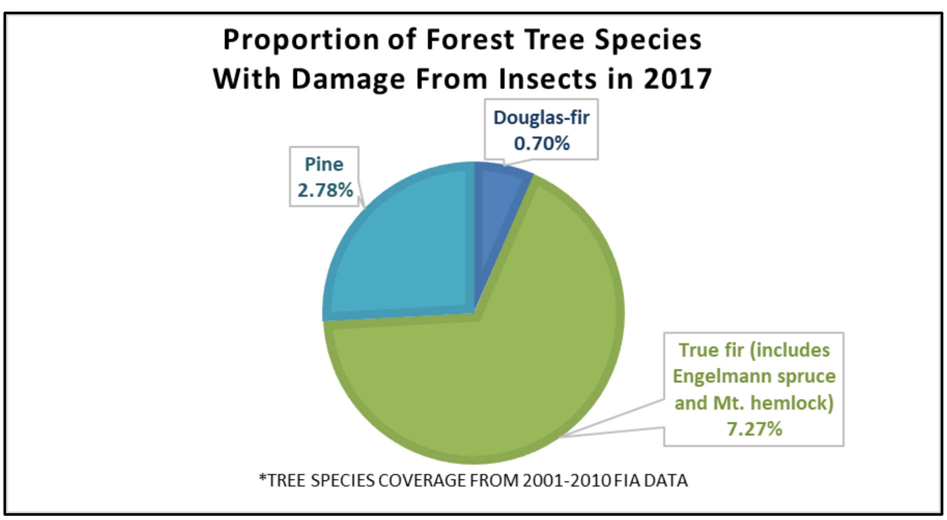


Figure 15 Estimated proportion of each tree species that has suffered damage in 2017.

Insect Damage Maps

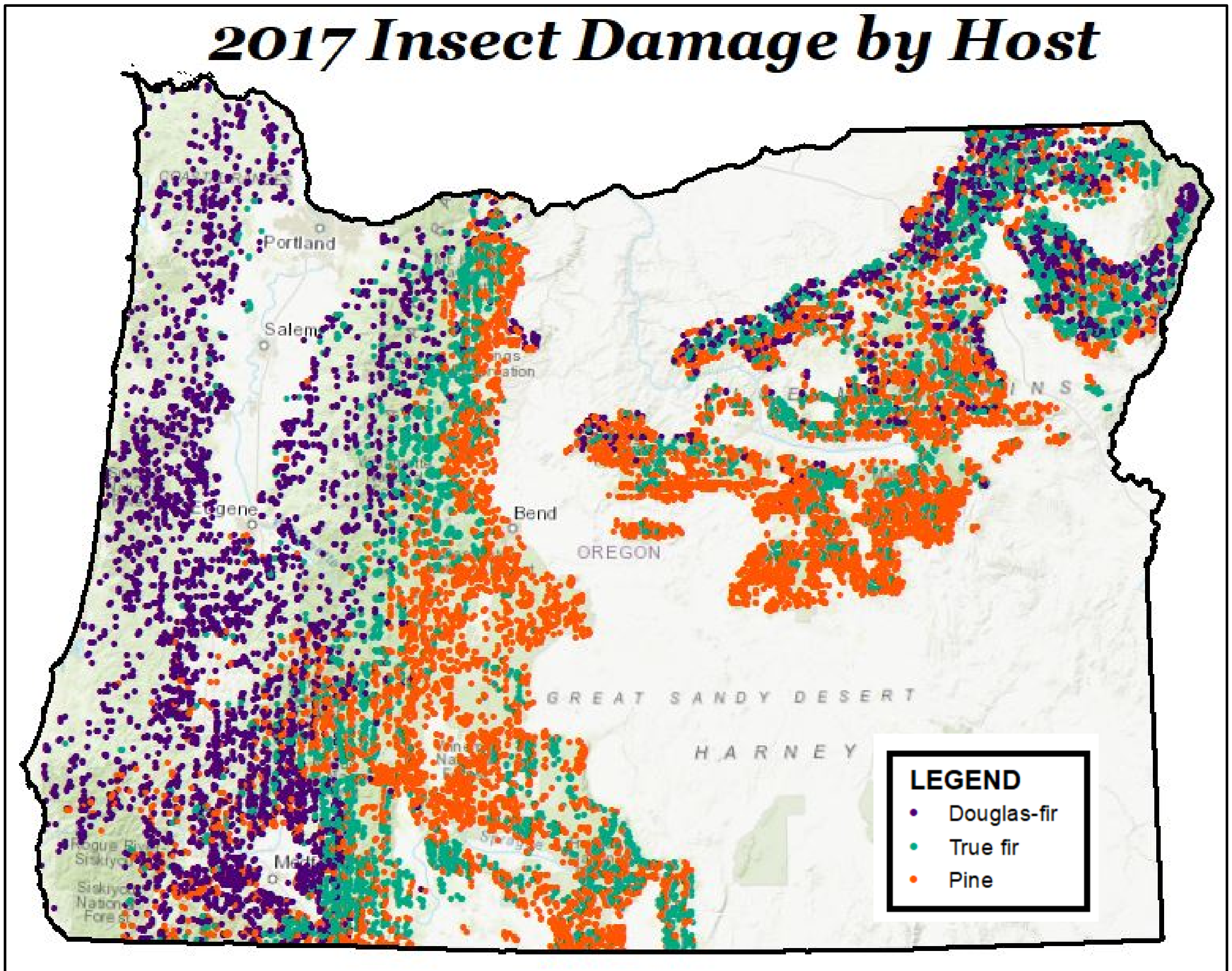
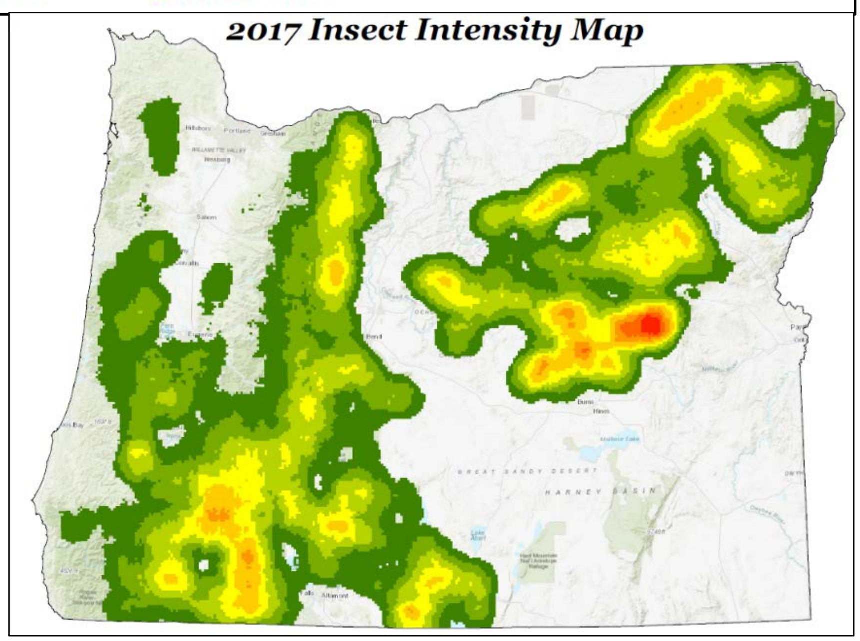


Figure 16 Map of estimated distribution of insect damage by host tree in 2017 (top) and intensity of insect damage from low to high in green to red, respectively (bottom).



Bark Beetles

Bark beetles are insects smaller than a grain of rice that create extensive tunnels of brood galleries under the bark (not within the wood), which girdle vascular tissues. These beetles can also vector various types of stain-causing fungi 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 woodboring beetles that typically tunnel into the wood. Stains from bark beetles (and ambrosia woodborers) and tunneling from ambrosias and other woodborers can greatly devalue timber. Each year ODF works with private landowners to prevent damage from bark beetle outbreaks through a USFS grant that assists landowners with a 50/50 cost share. In 2017, 45 projects were conducted over a total of 17,000 acres.

Bark beetle cost share program: http://www.oregon.gov/ODF/AboutODF/Pages/GrantsIncentives.aspx

Bark beetles in Douglas-fir:
The major bark beetle pest of Douglas-fir is the **Douglas-fir beetle** (*Dendroctonus pseudotsugae*), which typically attacks >10” dbh trees. This insect has the propensity to build up populations in areas with >5 downed trees per acre. Processing felled or blowdown trees before the first or second April, or application of the anti-aggregation pheromone MCH can prevent or mitigate beetle damage (Fig. 17). In recent years, Douglas-fir beetle has played a large role in picking off trees stressed by drought. Although we are used to seeing Douglas-fir all along the Willamette Valley, many parts of this region were historically oak savannah and not hospital to these conifers - particularly during droughts.

MCH factsheet: http://tinyurl.com/odf-foresthealth

Figure 176 Storm blowdown in large-diameter Douglas-fir (left; C. Buhl, ODF) and MCH repellant for Douglas-fir beetle (right; C.Buhl, ODF).

Secondary bark beetles such as Douglas-fir pole beetle and Douglas-fir engraver beetle may become more problematic in heavily stressed trees. They are common in dense plantings of young Douglas-fir, (especially old Christmas tree plantations) or older trees stressed by drought or waterlogging. Their galleries are more often found in smaller diameter trunks and branches and galleries reach 1-3” long whereas Douglas-fir beetle only attacks >10” diameter trunks and their galleries are significantly larger at 5-10” in length.

Bark beetles in pine:
There are several species of bark beetles that are major pests of pine in Oregon, which may overlap in some pine species. Determining the causal agent can be difficult from aerial surveys but ground checks can assist with verification where aerial signatures are not definitive.

Ips species commonly outbreak in dense stands of young pine (Fig. 18) or attack the tops and branches of large-diameter pine growing on poor or droughted sites. This species prefers fresh slash of 3-8" in diameter. Unlike many of our other major bark beetle species, *Ips* develops rapidly which can aid outbreaks, therefore timely thinning and management of slash is essential.

Slash Management factsheet:
http://tinyurl.com/odf-foresthealth

Figure 18 Dense Willamette Valley ponderosa pine where PCT is overdue is commonly attacked by Ips. Outbreaks are exacerbated by leaving fresh slash onsite before Ips *flights.*

Western pine beetle (*Dendroctonus brevicomis*) infests only ponderosa pine and prefers less vigorous or damaged, large-diameter trees. In 2017 larger-scale dieback from western pine beetle occurred in the southern Malheur National Forest – even in recently thinned stands (Fig. 19). This area was previously stressed by a pine butterfly attack (2009-2012) and drought (2011-2015). Bark flecking from woodpeckers seen in ponderosa can be an indicator of western pine beetle infestation.

Figure 79 Large ponderosa attacked by western pine beetle (L. Spiegel, USFS).

Mountain pine beetle (*Dendroctonus ponderosae*) can infest any of our pine species but has been most outbreak-prone in areas in Oregon with dense, contiguous stands of lodgepole pine (Fig. 20). Dog-haired stands of overgrown lodgepole pine are highly attractive to Mountain pine beetle. Areas where natural fire has been suppressed and density management has not been practiced allows lodgepole to quickly establish thick stands that become stressed and release chemical volatiles that are highly attractive to these beetles. Mountain pine beetle outbreaks are known to cause landscape-level swaths of tree mortality.

Figure 20 Dog-haired stand of lodgepole pine (C.Buhl, ODF).

Bark beetles in true fir:

Fir engraver (*Scolytus ventralis*) is usually a secondary pest in severely stressed true fir although it has become more of a problem for fir planted outside of its preferred range such as at lower elevations of the Willamette Valley (Fig. 21), or sunny hillsides past the foothills of the eastern cascades. Grand and noble firs are a common sight in the Willamette Valley but are often overgrown remnants of old Christmas tree plantations, or inhabiting pockets that have historically been feasible for their growth. The Valley with its intermittent rain and extended dry periods can be a harsh environment for these higher elevation species.

Figure 218 Overcrowding, drought stress and/or planting on poor, old agricultural sites can reduce true fir resiliency to fir engraver (uncredited).

Woodboring Insects

Wood boring insects include ambrosia beetles, roundheaded borers/longhorned beetles, flatheaded borers/metallic wood boring beetles, wood wasps and wood boring moth larvae. These insects, with exceptions, bore through bark and into the wood. Unlike bark beetles, which stay under the bark and do not bore into wood (Fig. 22). 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, has become a major pest of struggling Douglas-fir.

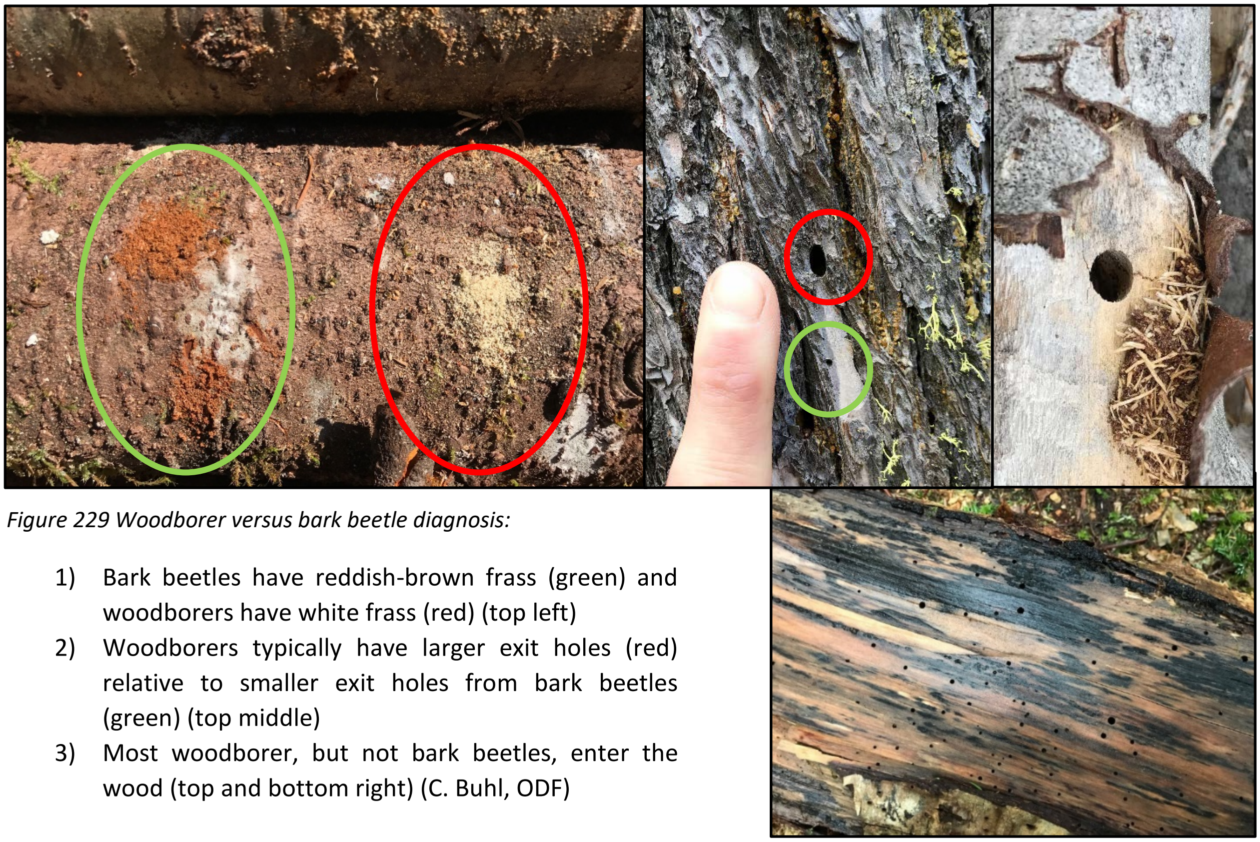


Figure 229 Woodborer versus bark beetle diagnosis:

1) Bark beetles have reddish-brown frass (green) and woodborers have white frass (red) (top left)
2) Woodborers typically have larger exit holes (red) relative to smaller exit holes from bark beetles (green) (top middle)
3) Most woodborer, but not bark beetles, enter the wood (top and bottom right) (C. Buhl, ODF)

Unlike other wood borers the **flatheaded fir borer** (*Phaenops drummondi*; Fig. 23) does not tunnel into the wood, instead it behaves like a bark beetle and creates galleries just beneath the bark. This insect is a major pest of Douglas-fir growing on dry, poor quality or fire-damaged sites. The most severe damage from this pest tends to occur in the Klamath-Siskiyou and South Cascade ecoregions (Fig. 25) and has been low, historically. Following extreme drought conditions in Oregon (2013-2015) mortality from this insect doubled in 2015 to 8,000 acres, then jumped to 45,000 acres in 2016, but has since dropped to 17,000 acres in 2017. Estimates of flathead-caused mortality are likely inflated due to the difficulty in discerning between flathead and Douglas-fir beetle although drought is often the primary damage agent. Much of this mortality is a result of Douglas-fir growing on harsh sites that are more suited to pine and oak, with the added stress of drought. Sites with thin soils, sunny exposures, low moisture availability, or microclimates caused by edge effects, southerly aspects or concave faces 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.

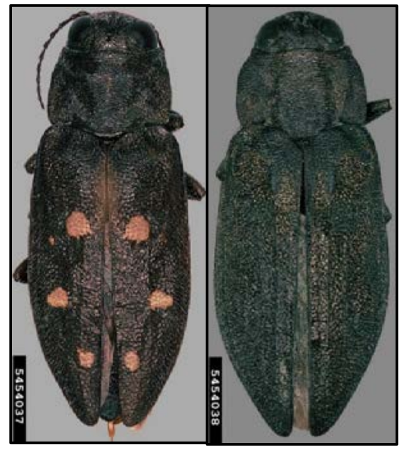


Figure 23 Flatheaded fir borer color morphs (Steve Valley, ODA). Adults are 7-11mm long.

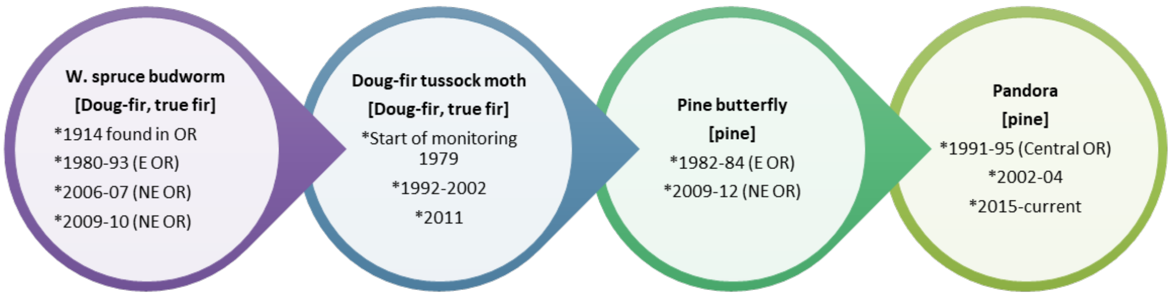
Figure 104 Woodpecker flecking in Douglas-fir can be an indicator of flatheaded fir borer infestation (B. Schaupp, USFS).

Figure 25 Mortality attributed to flatheaded fir borer in southwest Oregon (E. Goheen, USFS).

Defoliators

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.

Timeline of Major Defoliating Pests in Oregon



Pandora moth (*Coloradia Pandora*; Figs. 26 and 27) is a defoliator that is seen infrequently. This insect has a 2-year life cycle and in Oregon, larvae occur in even years and adults in odd years. Larvae feed on mature ponderosa, Jeffrey, lodgepole and sugar pine growing in loose volcanic or limestone-based soils. The first recorded outbreak was in the 1980's on the Klamath Indian Reservation. It has been estimated, through tree ring analysis, that approximately 22 Pandora moth outbreaks have occurred in in Oregon over the past 600 years. The last outbreak of this insect was from 2004-2008 in central Oregon, increased numbers of adults were seen in 2015 and 2017 and isolated pockets of defoliation occurred in 2016 and is expected again in 2018. Outbreaks can cause extensive defoliation, leading to growth loss and some tree mortality. Mortality is more typical during droughts or in association with bark beetle attacks. The 2-year life cycle of Pandora moth results in feeding only every other year, which allows time for pines to recover from defoliation.

Figure 126 Pandora moth adults laying eggs (R. Flowers, USFS).

Figure 117 Pandora moth wingspan is up to 4" inches across (C. Buhl, ODF)

Mature larvae and pupae are traditional foods historically collected by several Native American tribes such as the Paiute, Klamath and Modoc.

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.

Black pineleaf scale (*Dynaspidiotus californicus*) primarily infests ponderosa pine (Fig. 28) 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 where nitrogen fertilizers enrich pine tissues and insecticidal sprays depress natural enemies of scales such as parasitic wasps. Heavy pockets of infestation are often seen near Hood River and on harsh sites in the northeast. Symptoms of infestation may include discoloration or shedding of older needles, which are not easily visible in aerial surveys.

Figure 28 Black pineleaf scale on pine (C. Buhl, ODF).

Balsam woolly adelgid (*Adelges piceae*) is not native to Oregon but has been established on the West Coast since 1929. This pest has a white, 'woolly' appearance (Fig. 29) and attacks various true firs in Oregon. It feeds by piercing through bark, causing swelling and dieback on stems and branches. These pests are mostly stationary and may become established in an area, therefore becoming a chronic issue in true fir stands. Chronic damage can distort crowns and cause premature needle drop, which unveils dark lichens present in the crown giving trees a dark, purple color. Damage from the balsam woolly adelgid continues to be widespread and has been most damaging in subalpine and Pacific silver firs at high elevations in the Cascades and in eastern Oregon (Fig. 30). Damage from this pest dropped in 2016 and again in 2017, and is 50% less than the 10-year average - although these decreases may be due to the loss of hosts.

Figure 29 Adelgid (C. Buhl, ODF).

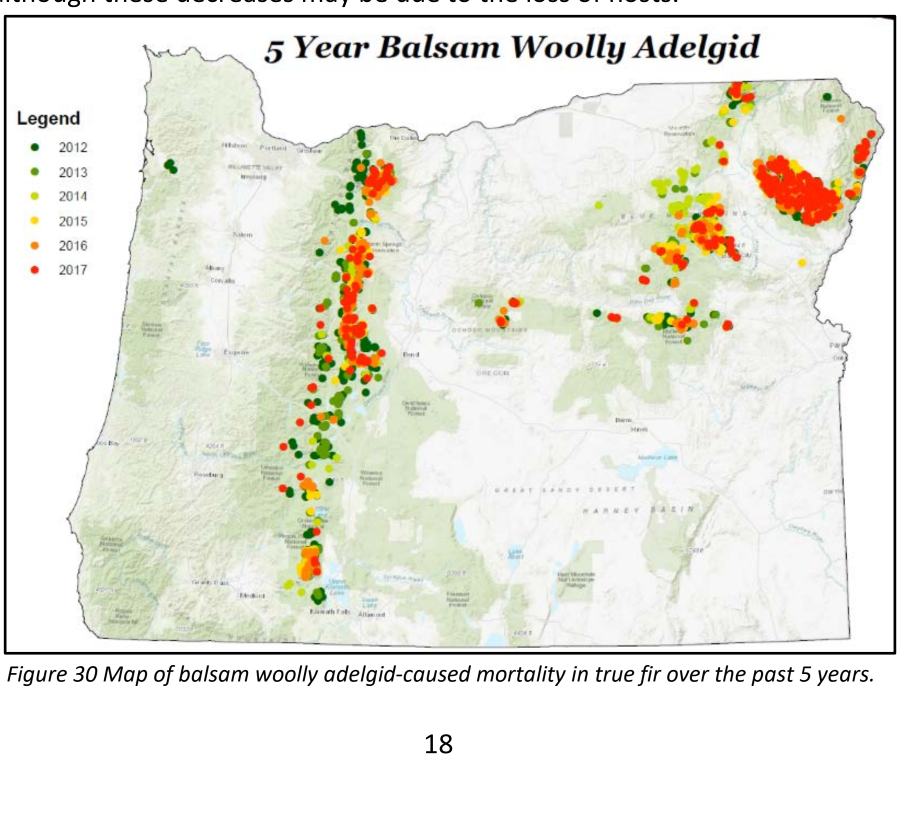


Figure 30 Map of balsam woolly adelgid-caused mortality in true fir over the past 5 years.

Oregon Bee Project

When people think of pollination they most often think of managed (non-native) honey bees used in agriculture, and perhaps some also think of native, wild bumble bees. However, we have a wealth of other native bees present in non-agricultural landscapes such as forests. Most trees in western forests are wind-pollinated, although understory plants and some broadleaf forest (and urban) trees rely on pollination services or provide forage for native pollinators.

Figure 31 Flagship industries such as Hampton Associates are integrating pollinator-friendly practices into operations such as seeding forage plants at regen sites (C. Buhl, ODF).

People also often think of nectaries (i.e., flower sources) as the main resources needed by these pollinators when in fact they also require habitat such as bare soil, sand, mud, hollow logs and stumps or materials such as coarse woody debris or pithy plant stems for nesting. Some wood-nesting bees even utilize abandoned bird nest cavities or exit holes created by woodboring beetles. Recent research indicates that major disturbances such as intensive logging and fire can actually increase abundance and diversity of many bee species by mimicking early successional dynamics that expose bare soil and create woody materials for nesting (Fig. 31), and increase light exposure understory forage.

ODF has partnered with OSU and Oregon Department of Agriculture on The Oregon Bee Project (OBP) to promote pollinator friendly practices in forestry. OBP is a pollinator health and education program that came out federal and state initiatives (2015 National Strategy to Promote the Health of Honey Bees and Other Pollinators and Oregon House Bills 3361 and 3362).

OBP mission: Bringing together Oregonians around a science-based strategy for protecting and promoting wild and managed bees through education, pollinator-friendly practices, and research.

Oregon Bee Project: www.oregonbeeproject.org
PolliNation podcast: http://blogs.oregonstate.edu/pollinationpodcast/

Stay tuned for Pollinator Week June 18-24 2018 for events near you

Forest Diseases

Non-native diseases

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 (Fig. 32). *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 by air currents. The pathogen can survive for months or even years in soil or plant parts. The disease also can be spread by humans transporting infected plants or infested soil.

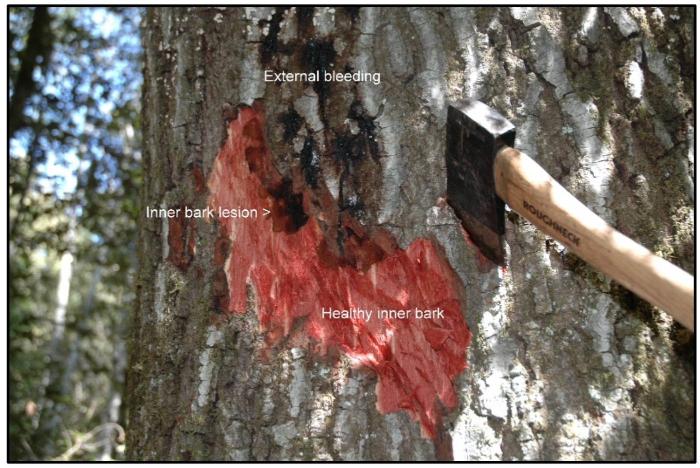


Figure 32 Stem lesion on tanoak caused by Phytophthora ramorum (A. Kanaskie, ODF).

In 2001, *P. ramorum* was discovered in Curry County, Oregon and immediately an interagency program formed with the goal of complete eradication. Spread of *P. ramorum* on state, private, and federal lands is managed by the designation of a SOD quarantine area under the authorities of the Oregon Department of Agriculture, which requires treatment of infested sites. Eradication treatments involve cutting and burning affected areas (Fig. 33). Even though eradication treatments eliminated disease from many infested sites, the disease has 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.

Figure 1333 Cutting and burning host plants to eliminate P. ramorum from an infested site near Brookings, OR (A. Kanaskie, ODF).

By 2010, Oregon's SOD program on forestland transitioned from eradication to slowing the spread of *P. ramorum*. 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 (Fig. 35). The quarantine area for *P. ramorum* was last expanded in 2015 to an area of 515 square miles in Curry County. The GIA was expanded to 89 square miles in 2017 to encompass untreated 2016 SOD infestations north and east of the previous GIA boundary.

In 2017, 39 new infestations were detected at or beyond the boundary of the GIA but well within the quarantine boundary. The EU1 lineage was detected for a third straight year in the Pistol River area of Curry County. Over the course of 2017, intensive ground surveys were conducted in the area resulting in the detection of 119 trees infected with the EU1 lineage, including saplings of Douglas-fir and grand fir.

Given the aggressiveness of the EU1 lineage compared to the NA1 lineage, ODF prioritized all EU1 infestations for eradication treatments.

The Chetco Bar Fire was the largest wildfire in Oregon in 2017, burning approximately 190,000 acres including areas currently and previously affected by SOD. The expansion of the fire was a wind driven event and was not a result of consuming dead trees from sudden oak death. Only 19% of SOD infestations identified from 2014 to 2017 were burned during the fire. Of the infestations within the fire perimeter, 10 infestations were treated, 4 infestations were partially treated, and the remaining 13 sites were untreated. Post-fire burn severity surveys reported most of these infestations to have very low or low burn severity. The risk of disease spread was low during direct firefighting efforts and mitigated by the use of vehicle wash stations before fire crews returned home. In 2018, aerial survey accuracy within the fire perimeter may be impacted by the difficulty in differentiating tanoak mortality from fire versus SOD.

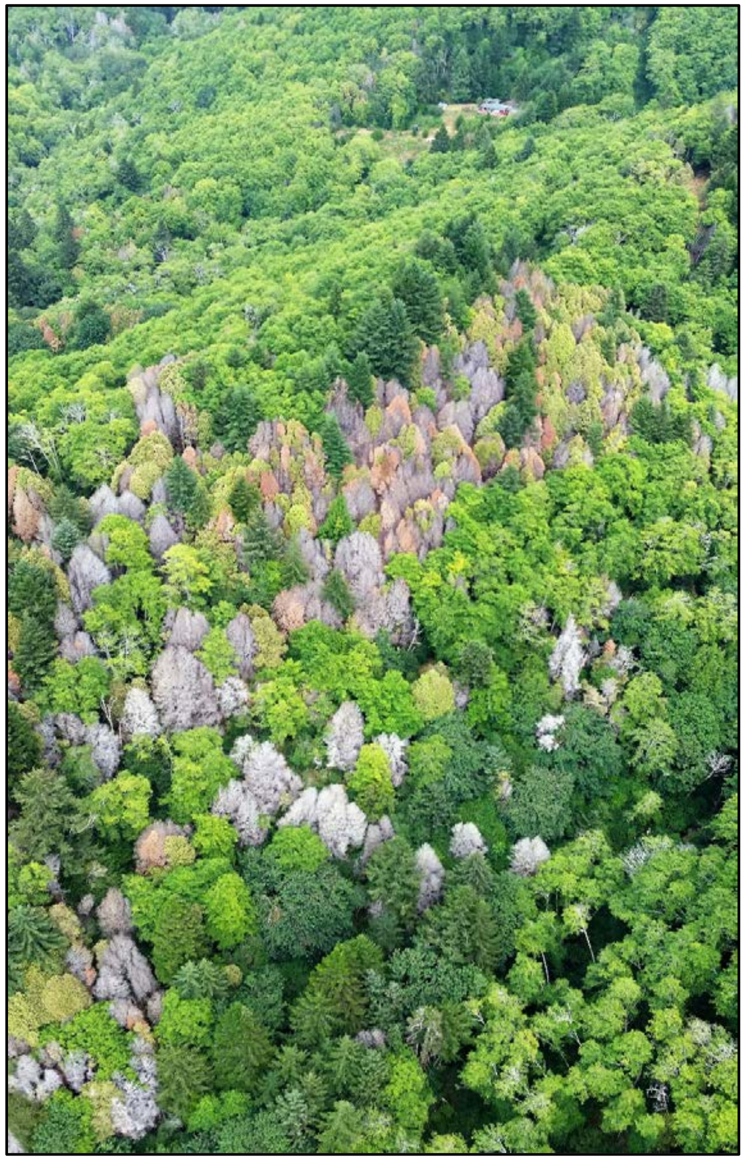


Figure 34 Aerial view of tanoak killed by sudden oak death (uncredited).

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 (Fig. 34), and the resulting quarantine regulations will disrupt domestic and international trade of many forest and agricultural commodities.

Sudden oak death information:
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

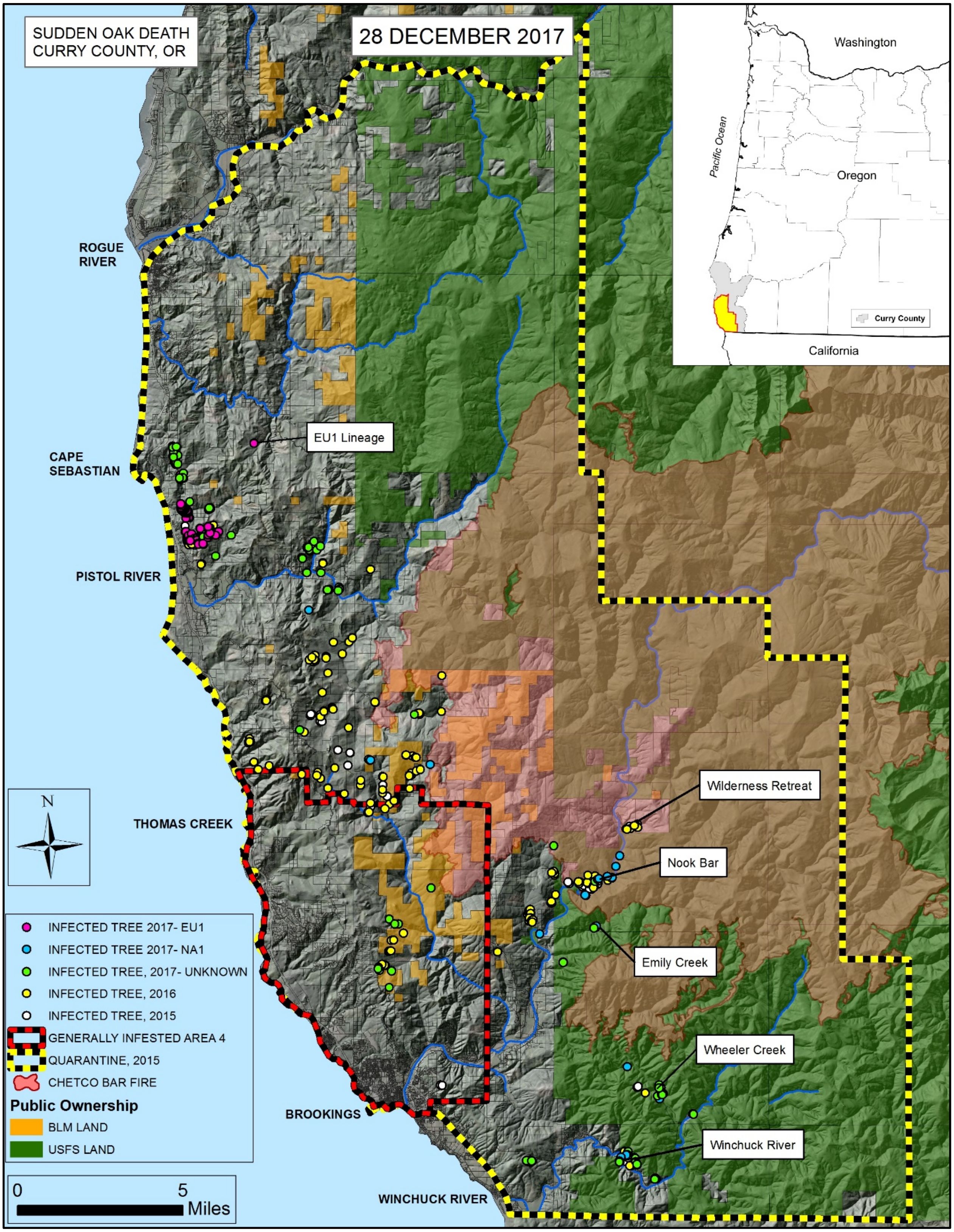


Figure 35 Quarantine boundary and location of trees infected with P. ramorum that were found in 2017. The infestation is more widespread inside the Generally Infested Area (GIA) than shown on the map, due to decreased survey effort there. Data from SOD aerial, stream and ground surveys.

Foliar diseases

Swiss needle cast (SNC) is caused by the native fungus *Nothophaeocryptopus gaeumannii* (previously *Phaeocryptopus gaeumannii*) and affects only Douglas-fir. Symptoms are yellowing and premature needle loss (Fig. 36). The host-pathogen interaction is unique, because of the intensity of the disease in a system where both the fungus and the host tree are native to the Pacific Northwest (PNW), where the disease originated. 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 (Fig. 37) 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, and limit stand management options. 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.

Figure 36 Sparse crowns of mature Douglas-fir damaged by Swiss needle cast, western Oregon (A. Kanaskie, ODF).

The yellow-brown hue of diseased foliage is best observed in mid-spring by aerial surveys. The first such survey was initiated in 1996 and has continued through 2016. These surveys have indicated a significant increase during this period in the area of visible symptoms from the air. Expansion of the disease has been verified using a cotemporaneous network of monitoring plots, which revealed that volume growth across the area was reduced by an average of 23% in the epidemic area.

Most areas with yellowing foliage detected by aerial surveys are within 25 miles of the coast. The easternmost areas identified as symptomatic were in the Cascade foothills approximately 70 miles from the coast. Until last year, aerial surveys in Oregon have been conducted annually. With 21 years of survey data available, the SNC Cooperative (SNCC) at Oregon State University decided to do a thorough aerial monitoring every other year, including Washington, Coastal Oregon, the Oregon Cascade foothills and northern California. Researchers in British Columbia decided to complement this effort and conduct an aerial survey in 2018.

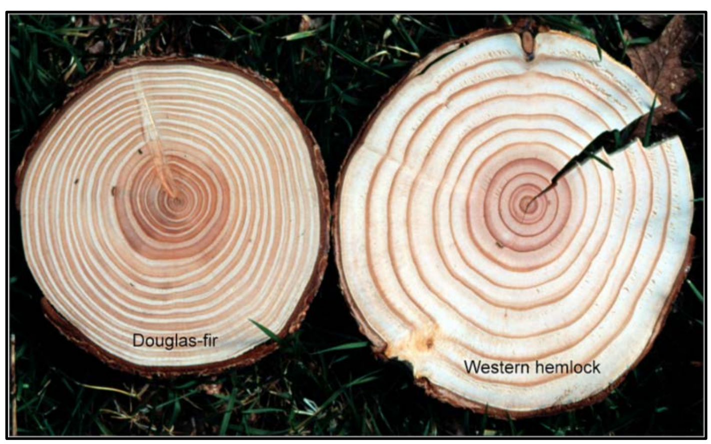


Figure 37 Foliage loss and damage from SNC can reduce tree volume growth by more than 50%. The Douglas-fir (left) is 5 years older than the western hemlock (right) and growing in the same plantation, but much smaller in diameter because of SNC (A. Kanaskie, ODF).

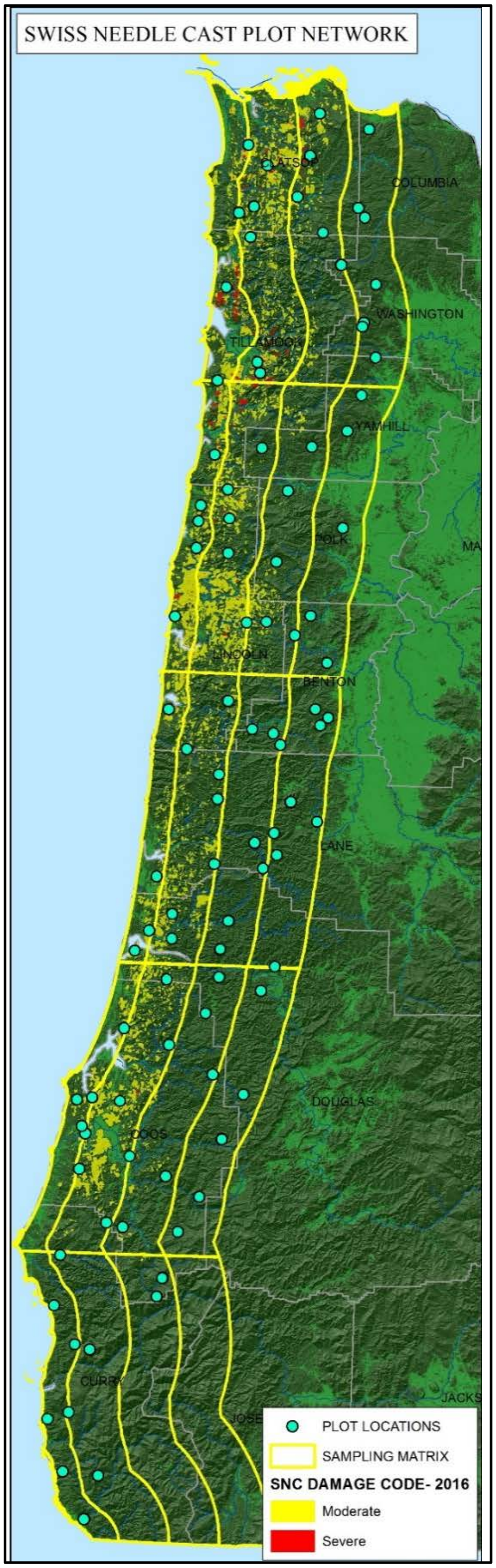


Figure 38 SNCC Research plot matrix and research plot locations for new study along with areas of Douglas-fir forest with symptoms of SNC detected in 2016. Data from SNC aerial survey.

While monitoring the presence of disease can be achieved qualitatively by aerial survey, quantitative assessment of SNC severity requires periodic measurements of individual trees. To address this, the SNCC decided to install a more extensive research plot network in 10-25 year old stands, which was completed over a three-year period in 2016. The 106 plots are distributed from the California border to southwest Washington and 35 miles inland (Fig. 38). Data from these plots will be collected for at least 10 years.

In 2017, 47 temporary plots were installed in young plantations in the Oregon Cascades foothills below 2,500 feet to establish a baseline range of foliage retention and relative disease severity. SNC symptoms were only found in plantations below 1,700 feet. The lowest foliage retention at these low elevations was 2.1 years and the average was 2.7 years.

The new sets of plots will not only provide periodic information about disease severity, growth loss and its geographic distribution, but will also offer sites for epidemiological, climatological or other SNC research. These studies will provide data to improve models that predict growth impact and geographic distribution of disease severity.

Swiss needle cast info, maps and GIS data:
http://tinyurl.com/odf-foresthealth
http://sncc.forestry.oregonstate.edu

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 (Fig. 39).

Figure 39 Web blight affecting Douglas-fir (A. Kanaskie, ODF).

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 into 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. In 2017, web blight was present in many areas of the Coast and Cascade Ranges, but at lower levels than reported in previous years. Pathogenicity testing continues at Oregon State University, along with efforts to sort out some of the other fungi associated with the disease.

Phytophthora needle cast of Douglas-fir, caused by *Phytophthora pluvialis,* was first discovered in New Zealand in 2008 and in Oregon in 2003. In 2014, Oregon State University confirmed the pathogenicity of *P. pluvialis* on Douglas-fir in Oregon. 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 (Fig. 40). The field symptom of bare lower branches (Fig. 41) often is coupled with abundant green or yellow needles covering the ground beneath the tree.

Figure 40 Yellowing needles in Douglas-fir infested by P. pluvialis (A. Kanaskie, ODF).

Figure 41 Needle cast on lower branched of Douglas-fir infested by P. pluvialis (A. Kanaskie, ODF).

In 2017, surveys recovered the pathogen in many Douglas-fir stands in western Oregon, and it was repeatedly recovered from foliage and streams in northern California. Some of the surveys recovered both *P. pluvialis* and Swiss needle cast from the same Douglas-fir tree in the sampled stand.

Leaf blight of Pacific madrone (*Arbutus menziesii*), suspected to be caused by *Phacidiopycnis washingtonensis* and other foliar pathogens, remained quite noticeable throughout the range of Pacific madrone in Oregon in 2017, although, the distribution was patchier than in previous years. In late winter, all leaves on affected trees can appear completely brown (Fig. 42), but they typically produce new shoots in spring. Significant branch dieback was observed on trees that have had successive years of damage, but tree mortality was not observed. Long-term effects of repeated severe damage from these foliage diseases are unknown.

Figure 42 Leaf blight of Pacific madrone remained visible in Oregon in 2017. Even when most foliage appears dead, new shoots continue to emerge the following spring (A. Kanaskie, ODF).

Root diseases

Several root diseases continue to affect Oregon forests, in many cases causing substantial damage. The degree of damage often reflects past management practices and fire exclusion, which have resulted in overstocked stands with a large component of disease-prone shade-intolerant species.

Figure 43 Mature Douglas-fir mortality caused by laminated root rot. This root disease is spread by root to root contact underground resulting in trees dying in clusters or root disease pockets (A. Kanaskie, ODF).

Laminated root rot, caused by *Coniferiporia weirii* (previously *Phellinus weirii)*, is the most destructive of these root diseases statewide, and is most damaging to Douglas-fir, true firs, and mountain hemlock (Fig. 43). Armillaria (*Armillaria spp.*) and Annosus (*Heterobasidion annosum*) root diseases are particularly damaging in southern and Eastern Oregon. Root diseases are difficult to detect via aerial survey, so annual damage trends are lacking. Manipulating the composition of stands to favor disease-tolerant tree species can mitigate root disease losses.

Unlike the other native root diseases in Oregon, **black stain root disease** is caused by a tree-killing vascular wilt-type fungus (*Leptographium wageneri)*, transmitted by root feeding bark beetles and weevils (Fig. 44). 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.

Observations during 2014 and 2015 suggest that the disease may be increasing in several parts of the Oregon Coast Range. In 2017, surveys continued in the northern part of the Coast Range to determine the disease severity and distribution in young stands, 2 to 6 years after their planting. Black stain root disease was detected in all surveyed stands affected up to 5% of the Douglas-fir trees. The threat of this disease to young stands still needs to be evaluated in heavily managed Douglas-fir plantations. Soil compaction has historically been a risk factor leading to increased incidence of black stain root disease, but in these cases many stands are on slopes with no history of ground equipment use.

Figure 44 Black stain root disease on young Douglas-fir in northwest Oregon. Black streaks indicate where the pathogen has colonized the tree's water conducting sapwood (A. Kanaskie, ODF).

Other diseases

Unusual **western red cedar decline** continued 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. 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. Minor bark beetle activity was observed in some trees. Some key pathogens such as *Phytophthora* species were not detected following laboratory testing and no evidence of other diseases were observed. The situation will continue to be monitored in the hopes that as the drought abates tree mortality will cease.

Invasive Species

Invasive Insects

Invasive woodborer survey along Columbia River: A special survey for exotic, invasive woodborers continued for a second consecutive year in 2017. The 3-year project is funded by the USFS Special Technology Development Program (STDP). The aim of the project is to test new pheromone lures in their ability to detect newly established, exotic woodboring species at sites across a wide environmental gradient stretching from Douglas-fir/western hemlock forests in the Coast range to semi-arid ponderosa pine forests in the eastern Cascades. Twelve sites were selected along the Columbia River based on their proximity to various forest types, shipping and travel corridors, industrial/commercial centers, metropolitan areas, and recreation sites (Fig. 45). At each site, eight unique pheromone lures were installed on funnel traps hung from rebar frames. The sites were visited and samples collected eight times between April and September. The survey was conducted April to September in 2016 and 2017, and a final year of survey is planned for 2018. Cooperators include the Oregon Department of Agriculture (insect identification) and Washington Department of Natural Resources (sample collection in WA).

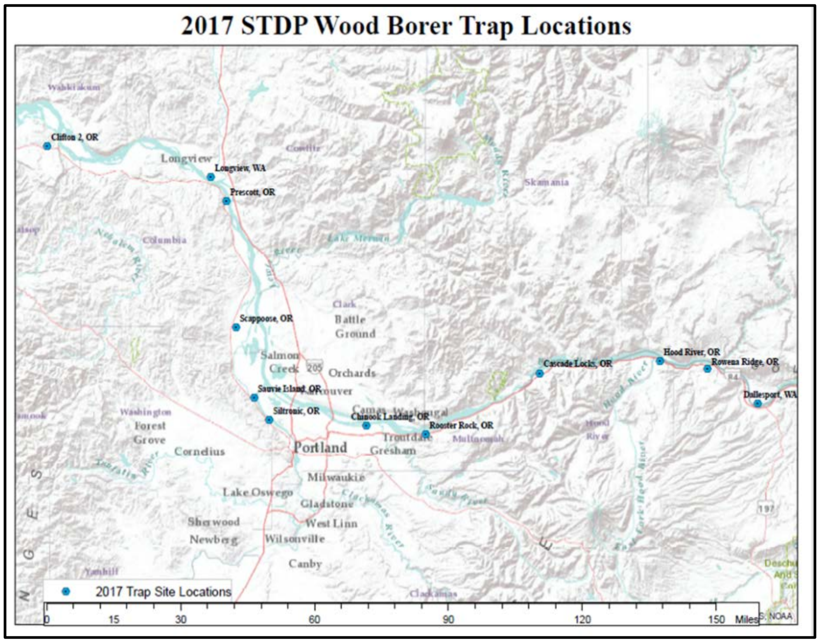


Figure 45 Survey sites in 2017 for the invasive wood borer project. At each site, 8 different pheromone lures were affixed to funnel traps. The sites were visited and samples collected 8 times between April and September.

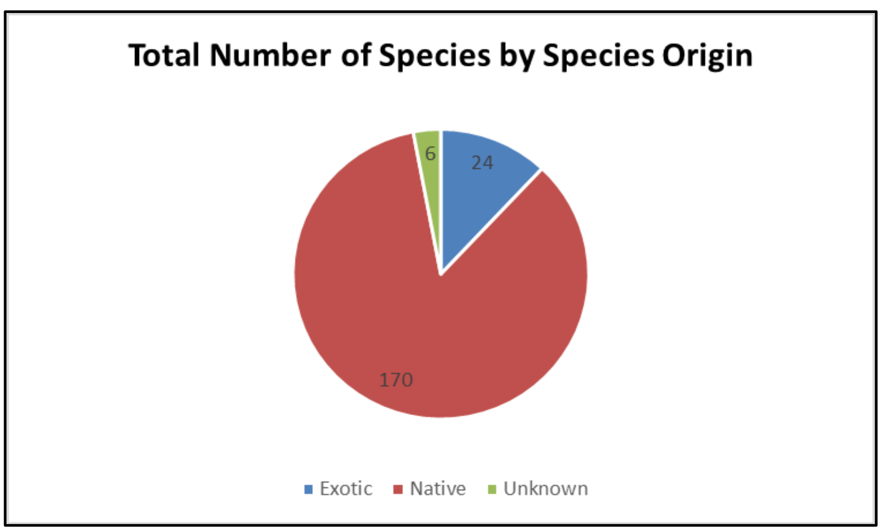


Figure 46 Number and origin of species identified across 2016 and 2017 in the invasive wood borer survey. Some specimens could not be identified due to damaged body parts or incomplete systematics but are likely native in origin.

To date, over 93,000 bark beetles and ambrosia beetles (Curculionidae: Scolytinae), wood-boring beetles (Buprestidae; Cerambycidae) and wood wasps (Siricidae) have been collected and identified across all sites. There have been 24 exotic species and 170 native species recorded (Fig. 46). Two exotic species were recorded for the first time in the Pacific Northwest. A single individual of *Chrysobothris rugosiceps* was captured in a trap baited with (-)alpha-pinene and ethanol on June 15 near Longview, WA. On May 24, two individuals of *Cyclorhipidion pelliculosum* were captured in different funnel traps (one baited with an exotic Ips lure and one with no bait) at Rooster Rock State Park, OR.

Figure 4147 Chrysobothris rugosiceps *(left; J. Basham) and* Cyclorhipidion pelliculosum (right; *Bugwood.org).*

The native range of *C. rugosiceps* (Fig. 47) is eastern North America and its host range includes oaks (*Quercus* spp.) and American chestnut (*Castanea dentata*). The native range of *C. pelliculosum* (Fig. 47) is Asia and, typical of many ambrosia beetles, it has a wide host range comprising several hardwood species such as maple (*Acer* sp.), chinkapin (*Castanopsis* sp.), and oak (*Quercus* sp.). Another exotic ambrosia beetle, *Xyleborinus saxensii* was captured at every site in the study and was the most abundant species encountered with over 77,000 individuals recorded, or 83% of the total trap catch (Fig. 48). This exotic ambrosia beetle, known as the fruit-tree pinhole borer (Fig. 48 inset), is native to Asia and has been on the west coast of North America since 1911. It has a wide host range, including almost all conifers and hardwoods, causing considerable economic damage to nursery trees in the horticulture industry.

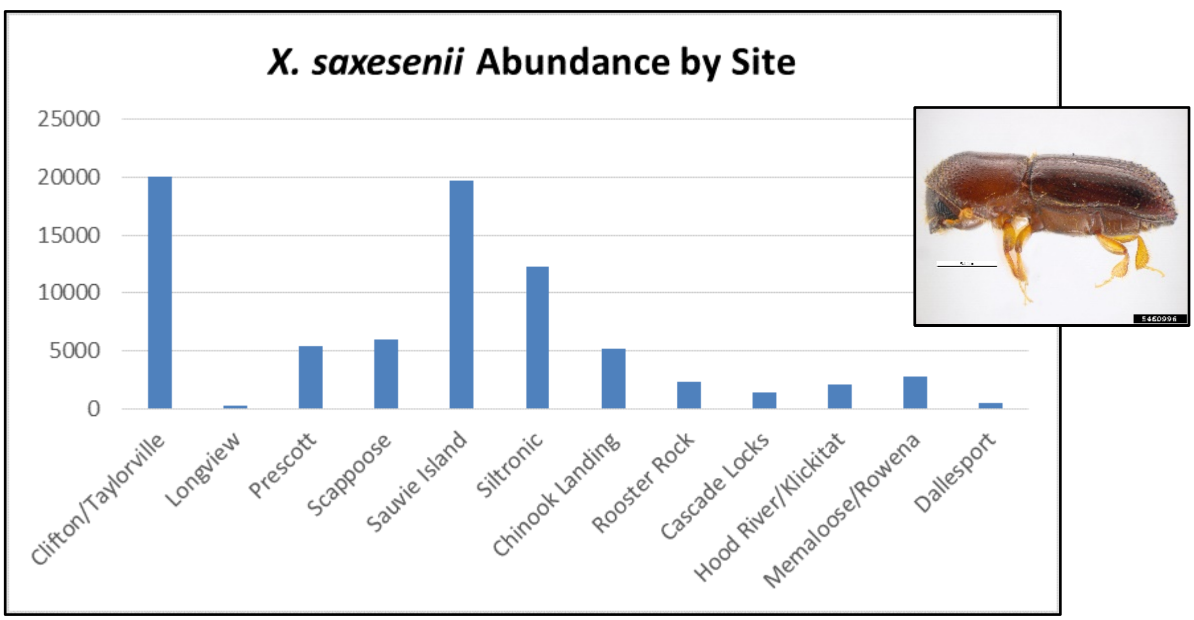


Figure 48 Abundance of the fruit-tree pinhole borer (inset; Bugwood.org) across study sites which are arranged west to east from left to right, respectively.

Invasive Plants

Orange hawkweed: In 2017, ODF staff documented for the first time the presence of Orange hawkweed (*Hieracium aurantiacum)* in Clatsop County in northwest Oregon. Orange hawkweed (Fig. 49) is a perennial plant in the sunflower family (Asteraceae) and proliferates in full sun, especially after a disturbance event, making it an opportunistic invader after timber harvest and road building activities. It invades open meadows, forest openings, and roadsides, and to date has been primarily restricted to isolated populations on Mt. Hood and Deschutes County (Fig. 50). Orange hawkweed is a Class A noxious weed in Oregon. Because of its legal status as public menace, private and government landowners and land managers are required by law to report and manage this plant (ORS 569, OAR 603-052-1200). Orange hawkweed is unlikely to pose a major threat to reforestation but its rapid spread and aggressive growth habits displace native plants and threaten native plant communities. In addition, it possesses several traits that make it adapted to surviving and establishing after fire, both wildfire and prescribed burning.

*Figure 49 Orange hawkweed (*Hieracium aurantiacum*; M. Shephard).*

Two reports of Orange hawkweed in Clatsop County were submitted to the ODF Forest Health Unit in 2017. The first was from a private landowner in Astoria in June. The identity was confirmed and the occurrence was reported to the Oregon Department of Agriculture. A pest alert was posted in the area. The second report was provided in August from Clatsop State Forest staff. The reported site was a radio tower road. Photos indicated the presence of Orange hawkweed at this second site but the flowers were bagged and disposed before a positive identification could be made. A survey of the surrounding road system in August did not yield any further plants. Expanded surveys on Clatsop State Forest and outreach to the public and private landowners will be conducted in 2018 in order to determine extent and severity of Orange hawkweed infestation at the site in Clatsop State Forest. Then, appropriate countermeasures, such as eradication or containment, can be taken to reduce future ecological and economic costs associated with this noxious weed while still feasible and practical.

Figure 50 Orange hawkweed (J. Nielson).

Oregon Forest Pest Detector

For the fourth year, ODF Forest Health team members served in the interagency Oregon Forest Pest Detector (OFPD) program. The USDA-funded OFPD, coordinated and led by Oregon State University Extension Forestry, aims to train arborists, landscapers, park workers and other professionals on the early signs and symptoms of priority invasive forest pests. Using a combination of online presentations, face-to-face seminars and field training courses, over 400 professionals have been trained as "First Detectors" of emerald ash borer and Asian long-horned beetles. The OFPD works with the Oregon Invasive Species Council member agencies 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. The overall goal is to detect key forest invaders early in their invasion establishment when eradication is still feasible.

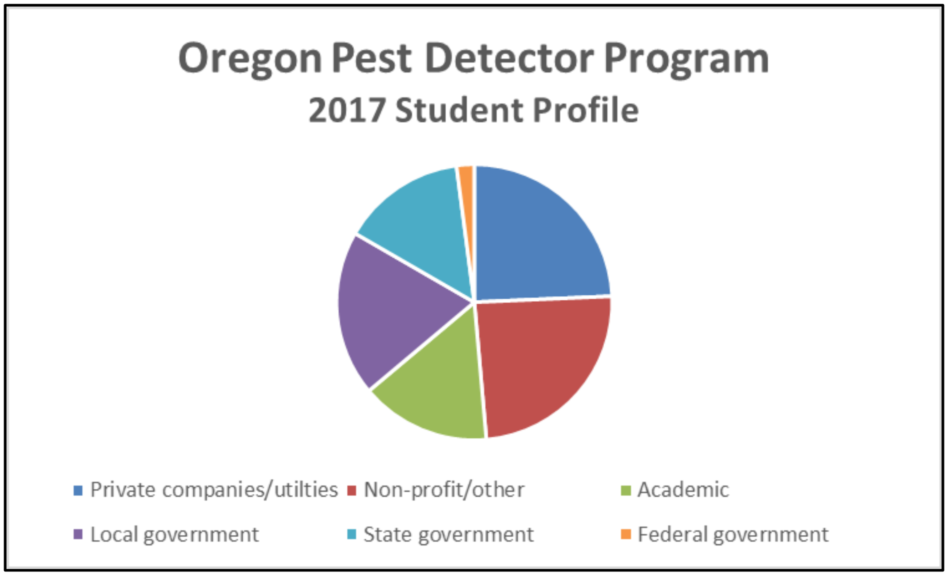


Figure 51 Profile of students that completed Oregon Forest Pest Detector training in 2017. The total number of students that received certification in 2017 was 144. There were eight classes taught at six locations in 2017.

In 2017, eight OFPD classes were taught in Corvallis, Milwaukie, Philomath, Portland, Eugene, and Central Point. There were 144 students from 15 counties (Benton, Clackamas, Clatsop, Crook, Curry, Deschutes, Jackson, Josephine, Lane, Linn, Marion, Multnomah, Tillamook, Wallowa, and Washington) representing a wide variety of employer types (Fig. 51). Two new field courses were installed at Peavy Arboretum (Corvallis) and Central Point. The new field courses, along with those already established in Portland, Milwaukie, Hillsboro, Salem, Corvallis and Eugene, are comprised of marked trees with simulated attack which aim to test students' knowledge and skills at invasive species identification. A new teaching module was developed for goldspotted oak borer (*Agrilus auroguttatus*), joining other modules on emerald ash borer, Asian longhorned beetle, Asian gypsy moth, introduction to invasive species, pathways of introduction, and how to file invasive species report. There were 17 reports (2 insects, 15 plants) submitted to the online hotline by OFPD graduates in 2017. All identifications were negative for the target species.

Oregon Forest Pest Detectors current class schedule: http://pestdetector.forestry.oregonsate.edu
Report suspected invasive species on Oregon Invasive Species Online Hotline:
https://oregoninvasiveshotline.org

Forest Health Resources

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.:
ODF insect & disease fact sheets: http://tinyurl.com/odf-foresthealth
ODF insect training videos: https://tinyurl.com/ODF-FH-videos
USFS insect and disease fact sheets: http://tinyurl.com/usfs-fidl
Forest health info: http://www.fs.usda.gov/main/r6/forest-grasslandhealth/insects-diseases
OSU Oregon tree ID: http://oregonstate.edu/trees/name_common.html

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

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
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
Blakey Lockman, 503-808-2997, blockman@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
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

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