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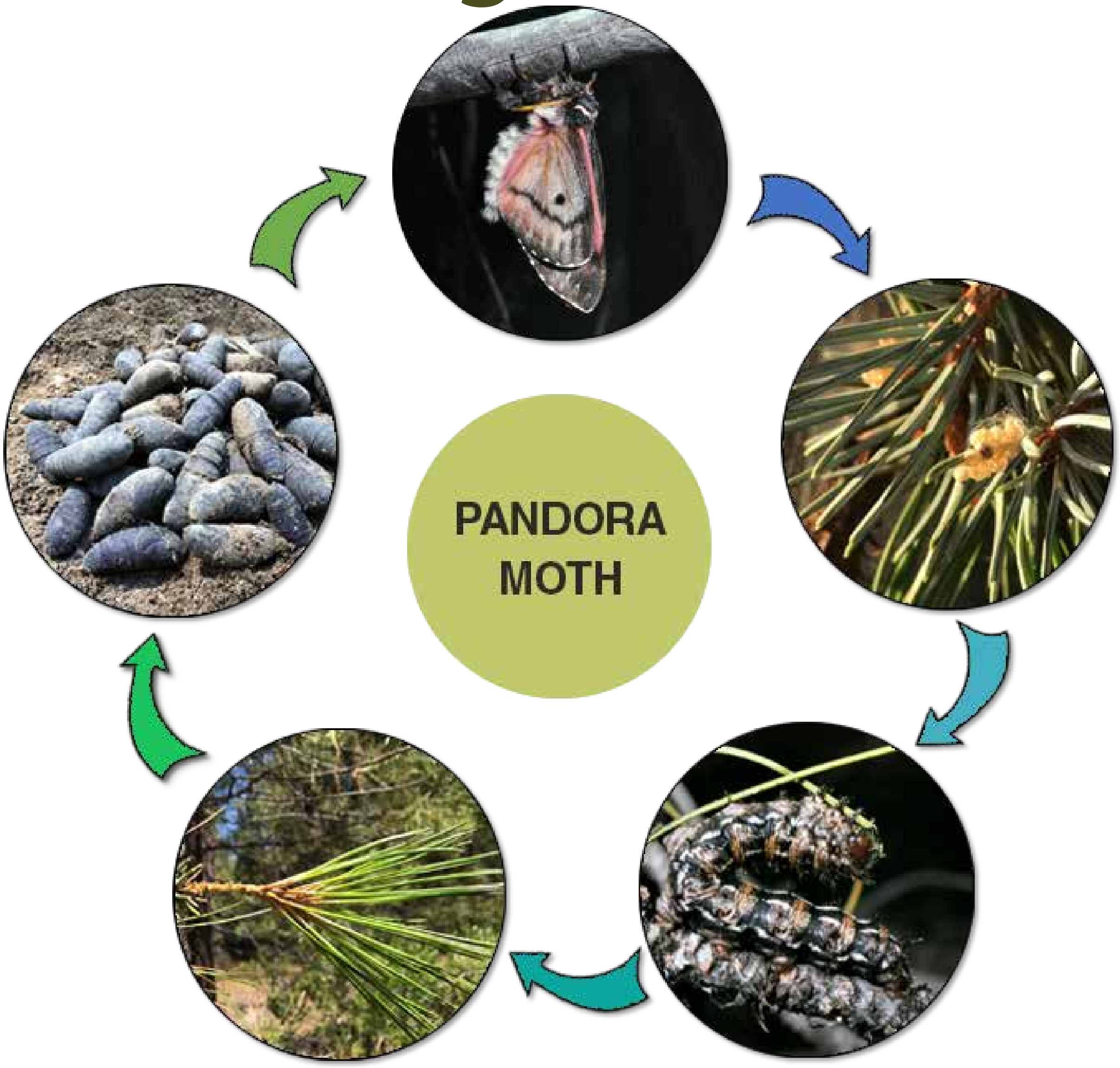
Forest Health Highlights in Oregon - 2018



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Forest Service March 2019

Pacific Northwest Region
Forest Health Protection

Oregon Department of Forestry
Forest Health Program

FOREST HEALTH HIGHLIGHTS IN OREGON - 2018

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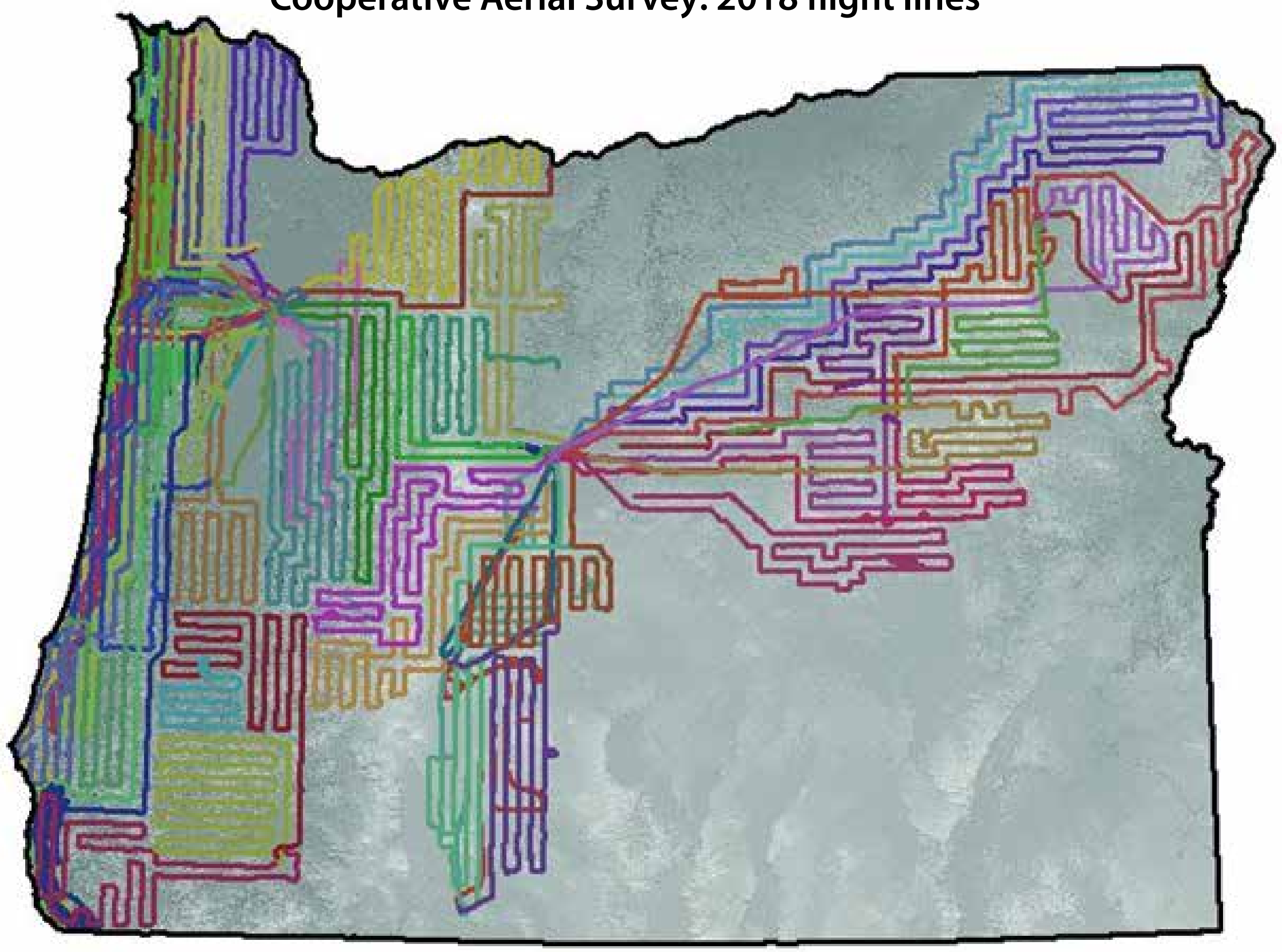
Cooperative Aerial Survey: 2018 flight lines



Front cover: Pandora moth (Coloradia pandora) life cycle showing adult ➲ eggs ➲ larvae ➲ feeding damage ➲ pupae (C.Buhl). The complete cycle requires 2 years. A periodic Pandora moth outbreak has been occurring in central Oregon since 2015.

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LANDOWNER RESOURCES

OREGON DEPARTMENT OF FORESTRY (ODF) RESOURCES:

Connect with your local ODF stewardship forester to get stand management guidance, diagnose and troubleshoot issues and learn about incentive programs: https://tinyurl.com/ODF-forester

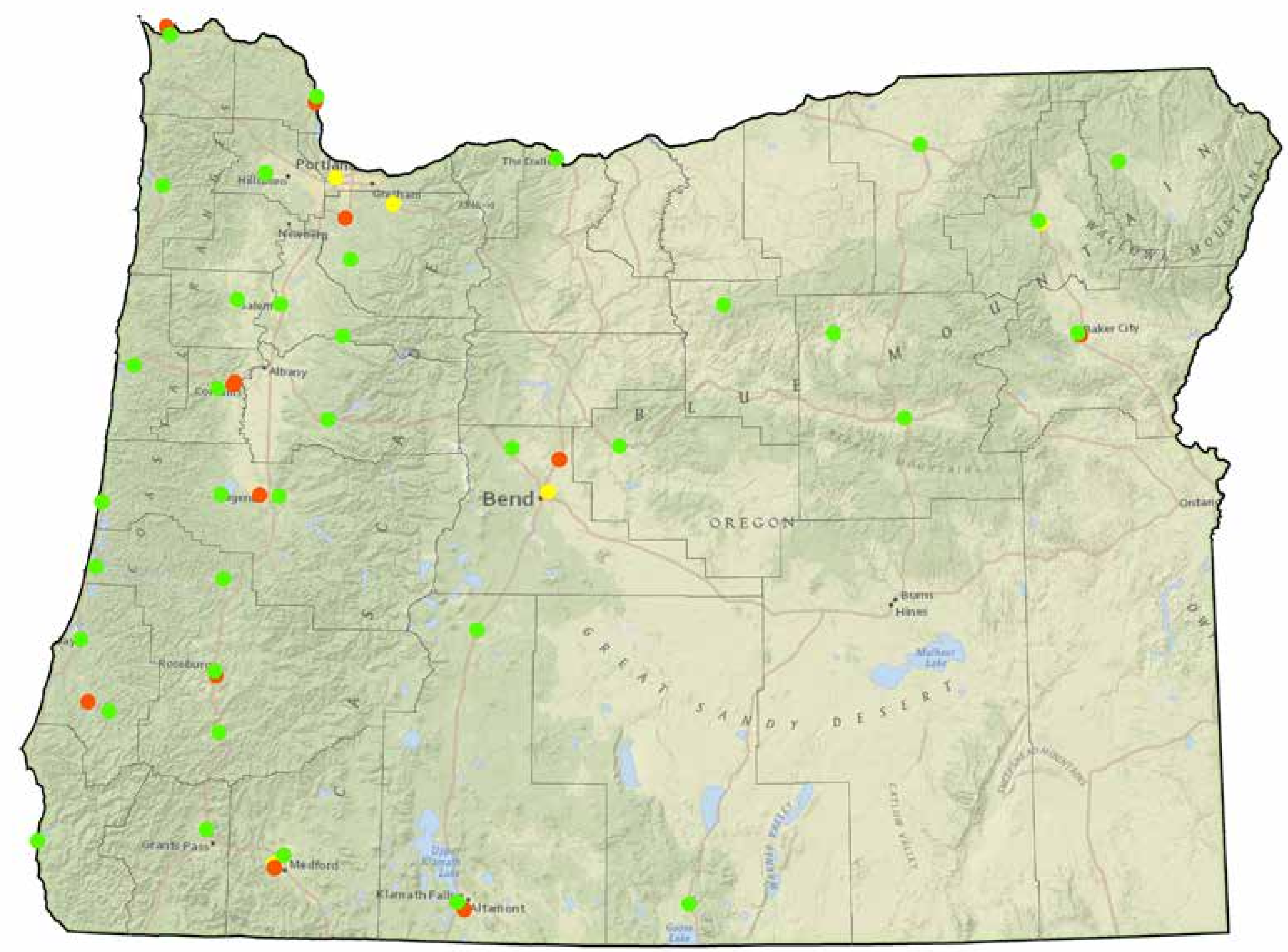
Connect with the ODF Forest Health team to diagnose and manage abiotic stressors, insects, diseases, weeds and other invasive species. Also visit the ODF Forest Health website for factsheets and training videos: http://tinyurl.com/odf-foresthealth

USDA FOREST SERVICE (USFS) RESOURCES:

(Federal agencies and Tribes only) Connect with USFS Forest Health Protection specialists to diagnose and manage abiotic stressors, insects, diseases, weeds and other invasive species: https://www.fs.usda.gov/detail/r6/forest-grasslandhealth/insects-diseases/?cid=stelprdb5287909

OREGON STATE UNIVERSITY (OSU) FORESTRY EXTENSION SERVICE RESOURCES:

Connect with your local OSU Forestry Extension agent to get stand management guidance and to diagnose and troubleshoot forest health issues: https://tinyurl.com/OSU-forester



Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Figure 1. Map of ODF (green), USFS (yellow) and OSU (orange) unit offices.

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 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 higher elevation 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 this information 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. Information for some of 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. Also note that totals reflect acres ***with*** not ***of*** damage or mortality, meaning that not every tree on that site is injured or killed. 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.

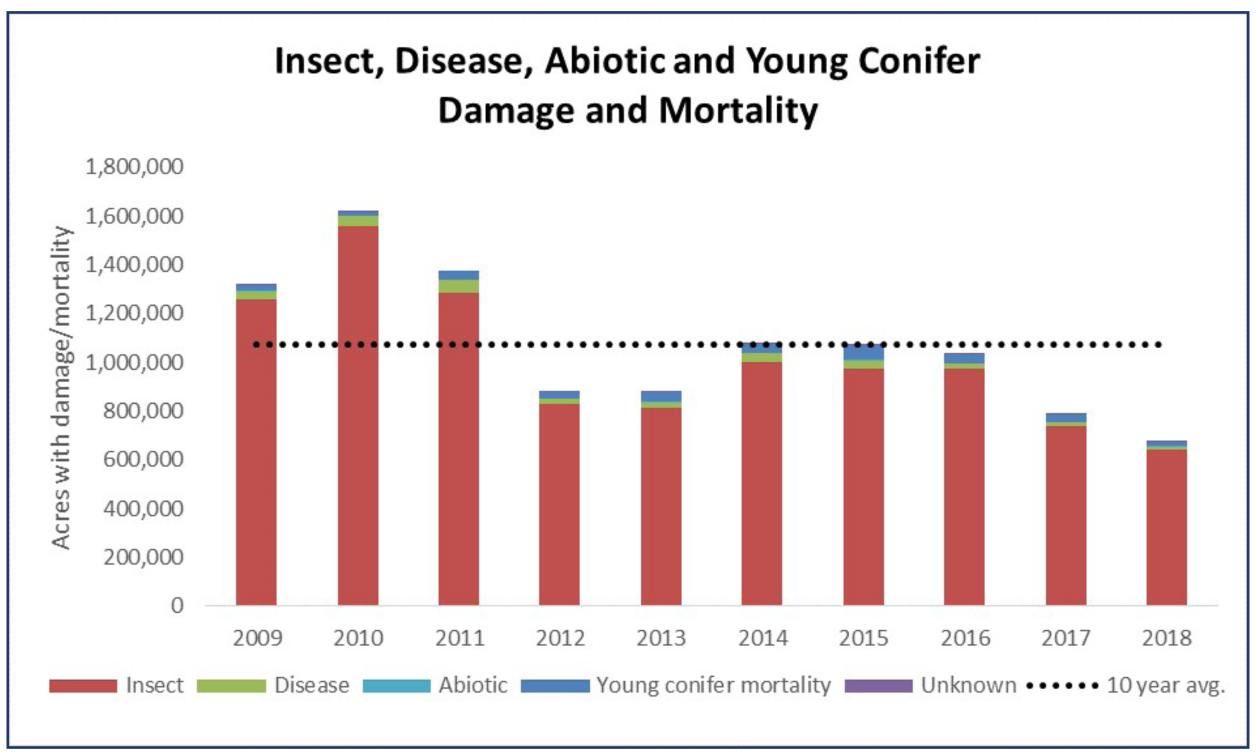


Figure 2. Of the approximately 28 million total forested acres aerially surveyed in 2018, almost 680,000 acres contained damage or mortality that could be observed in aerial surveys.

AERIAL SURVEYS

In the 1940's there was a strong interest in maintaining the country's timber economy, and growing concern for the health of our region's forests in relation to impacts on the timber supply. At the same time the aviation industry was blossoming. The combination of these interests created a union 72 years and counting in the form of an annual aerial survey of insects and diseases across Oregon forests.

On an annual basis, ODF cooperatively surveys the forest land base with the USFS. Beginning in 1947, observers from each agency climb into small aircraft like ODF's twin engine Partenavia Observer (Fig. 3) or a Cessna 206 and conduct a data collection process called 'sketch-mapping'. With an observer on each side of the plane, damage to the forest is drawn on a map (to record the location and volume of damage) and noted with an educated assumption of the insect, disease or abiotic stressor impacting the tree(s). In the early days this was done on large paper maps that had to be folded, un-folded, re-folded, and written on as the plane bumped about in summer turbulence. Beginning in the early 2000's the process was moved to a digital system with a moving map screen, aerial photos, and a plethora of additional information.

Figure 3. ODF aerial survey plane (Partenavia Observer)

Each year a general overview survey covers roughly 28 million acres. Surveyors look for all types of damage to the forest (foliar diseases, bark beetles, defoliators like western spruce budworm, hail damage, and many others). Additional special surveys are flown as needed (sometimes using helicopters) for damage agents like Swiss needle cast (SNC), sudden oak death (SOD), Pandora moth, oak looper, and invasive plants such as gorse. With these added surveys, the agencies cover a total of 35 to 41 million acres each year. Damage from some agents observed in these surveys may be cyclical (e.g., Douglas-fir tussock moth), consistently large contributors to damage (Swiss needle cast), or increasingly important issues (drought in species such as Douglas-fir).

Figure 4. Total hours of survey in 2018 for each agency on each survey.

Agency	General survey	General + SOD	SOD (helicopter)	Pandora	SNC	Young conifer mortality	Total
USFS	76.8			5.9			82.6
ODF	21.2	6.8	14.6		20.7	26.2	89.5
Total	98.0	6.8	14.6	5.9	20.7	26.2	172.1

Successful aerial surveys require a clear view of the trees. The 2018 survey year was slow to get rolling due to cloudy spring weather and was difficult to complete due to another intense fire season that suspended surveys until the return of clear skies. Smoky skies are yet another negative impact of overdue, and thus subsequently catastrophic, fires on natural resources and their management.

Overall damage observed during the 2018 aerial survey was lower than the 10-year average by more than 300,000 acres (Fig. 2 in Summary section). Most of this damage was due to bark beetle activity in the eastern two thirds of the state, which held almost even with the previous year. There was an uptick in insect defoliation due to a special flight in June for Pandora moth damage in central Oregon. This special survey is not normally flown unless requested by field personnel. As is typically seen, the majority of the area with damage is on federal lands, followed by industrial ownership, small non-industrial, state, and tribal lands (Fig. 5).

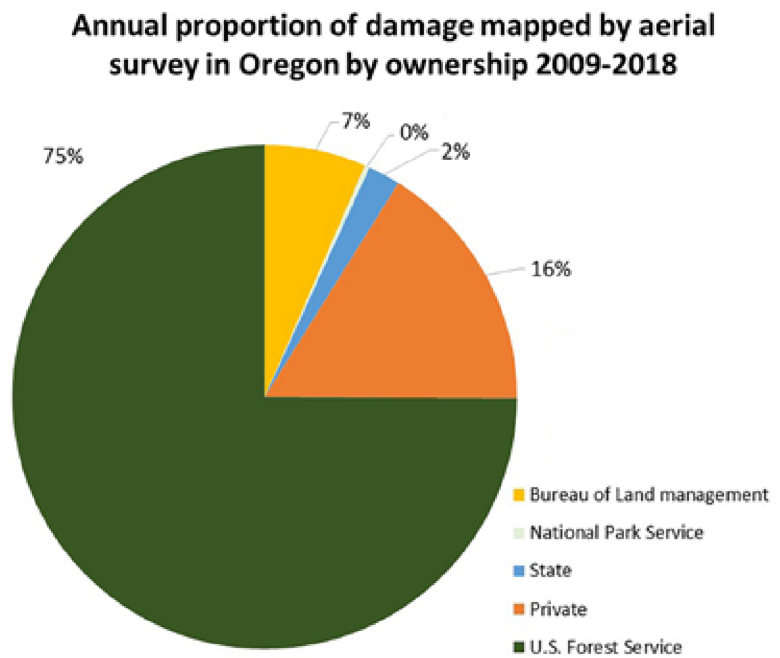


Figure 5. Damage detected by survey proportioned by ownership

It is important to note that the aerial survey metric is acres ***with*** damage not ***of*** damage, meaning that not all the trees in the indicated areas experienced mortality or defoliation. Much like a fire, the majority of the trees in a 'damaged area' are injured or dead but there will be intermixed patches of trees with less or sometimes no damage.

As part of a national network that conducts aerial surveys, current and future survey efforts in the Pacific Northwest are being implemented using a new digital data collection software system with a new metric of observation: the percent of treed area affected. This new system more clearly designates the portion of the indicated area that is undamaged, provides reliable data that can more easily be compared across ecotypes and management strategies, and is more compatible with the data produced by satellite remote sensing systems. While this is a change from the digital data collection system that has been used for two decades, shifts in aerial survey metrics have occurred in the past. For questions about this new system called Digital Mobile Sketch Mapping, its use, the metrics involved, or aerial surveys in general, please contact the ODF or USFS aerial survey staff.

It is also important to remember that aerial sketchmapping survey work can be highly subjective to individual surveyors and is applicable to landscape level trends. It should not be used for fine scale management decisions such as silvicultural prescriptions or single stand management.

ABIOTIC STRESSORS

Climate and weather play a primary role in determining forest health conditions. Events that stress trees reduce growth and decrease their ability to defend and tolerate additional stressors such as insects and diseases.

HEALTHY TREES = RESILIENT TREES

One of the major reoccurring stressors in Oregon forests has been drought, whose frequency is an indicator of climate change. Oregon has a diversity of forest ecosystems due to variations in latitude, elevation, topography, and proximity to the ocean and mountains (rainshadow effects). All of these factors play a role in determining the impacts of altered temperatures and precipitation (rain as well as snow) levels. Additionally, soil and groundcover type, local water use and watershed dynamics can place different pressures on water storage capacities.

Droughts are not defined as record high temperature or record low precipitation but by high temperatures that are frequent or continuous, combined with low and inconsistent precipitation. Droughts are most damaging when we have a series of hot and dry days during spring and summer growing periods, or when winters are warmer than usual with little rain or snowpack to recharge waterways and water storage areas. Since 2012, these scenarios have been frequent and most of Oregon has been in a drought.

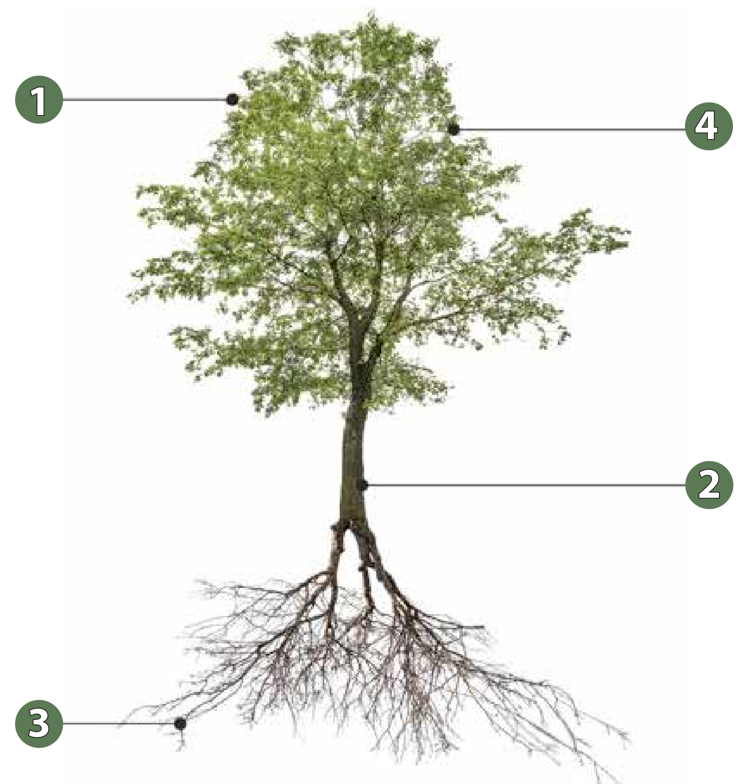
Direct impacts of drought to trees are reduced growth and mortality. Although trees may not always show strong evidence of direct drought damage (Fig. 6), they are weakened by the indirect impacts of drought such as increased susceptibility to insects and disease or heightened wildfire risk from dying plants that add to dry fuels. Drought damages trees that support urban and rural ecosystems and fuel Oregon's timber economy. Drought also drains resources that support ecotourism and wildfire control in Oregon.

Figure 6. Diagnostic indicators of drought stress include sparse crowns sometimes accompanied by stress cones (left), flagging (center), topkill (right), asymmetrical crowns from prematurely shed branches, and a pattern of compressed annual ring growth (C. Buhl, ODF).

ODF Drought fact sheet
http://tinyurl.com/odf-foresthealth

HOW DOES DROUGHT STRESS AND KILL TREES?

1. Leaf pores (stomata) open for gas exchange to make 'food' during photosynthesis. These pores may close frequently during drought to reduce moisture loss, which can lead to carbon starvation.
2. Evaporative tension is created in vascular tissues that act as straws, pulling water from soil through roots up to leaves that release it as water vapor through stomata. This tension can break vascular tissues, leaving trees with fewer resources to support essential functions when moisture returns.
3. Dry roots atrophy, preventing trees from obtaining moisture and nutrients.
4. Carbon resources are used to keep trees alive, but less is allocated toward producing defense compounds that protect trees from insects and diseases.



TREE SPECIES	DROUGHT TOLERANCE	HIGH RISK SCENARIOS
Western redcedar Western hemlock Pacific silver fir Subalpine fir Engelmann spruce Sitka spruce Red alder Black cottonwood	Low	Western redcedar in sun-exposed areas with soils having poor moisture retention
Grand and noble fir Quaking aspen	Low – Medium	Grand and noble fir at low elevations in the Willamette Valley and on overstocked Christmas tree farms
Douglas-fir Lodgepole pine Western white pine Western larch Bigleaf maple	Medium	Douglas-fir growing in oak/pine-dominated habitat or open-grown on poor sites
Ponderosa pine Incense cedar Western juniper Oregon white oak Pacific madrone	High	Even some of these species may be at risk during droughts if they are open-grown on poor sites such as rocky soils

2018 DROUGHT CONDITIONS

Most of Oregon continued to experience below normal precipitation and above normal temperatures in 2018 (Fig. 7), which is expected to continue despite some improvement in late winter 2019.

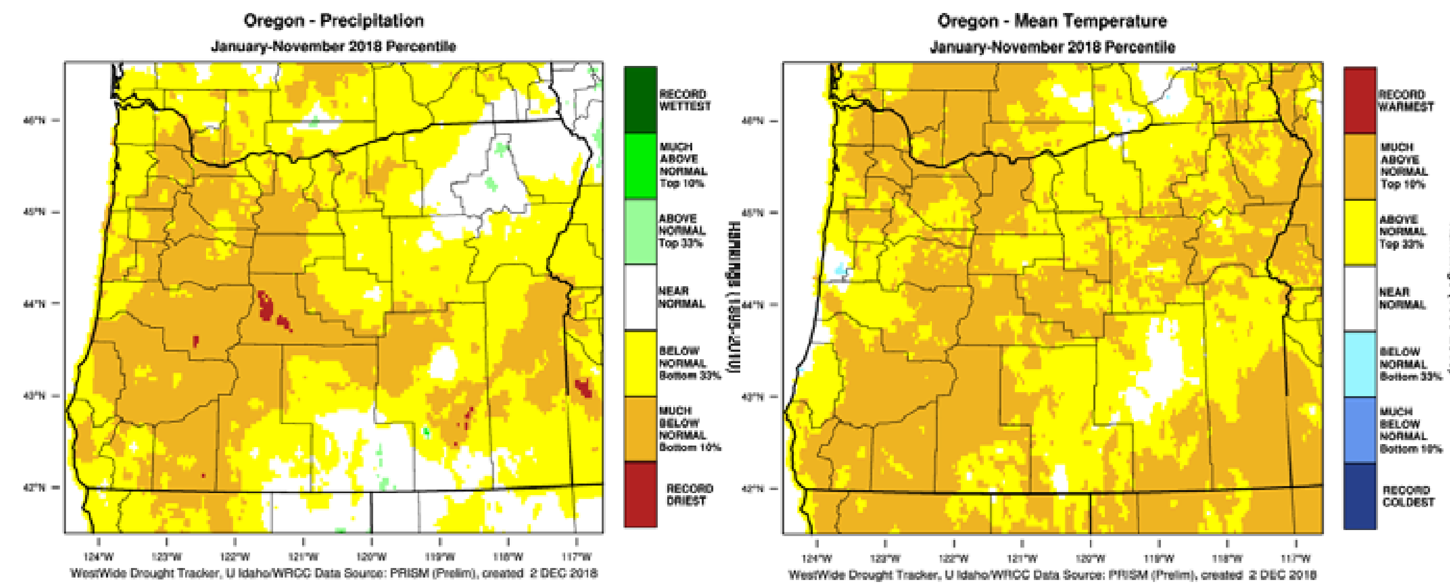


Figure 7. Average precipitation and temperature levels from January-November 2018, relative to the average normal based on 115 years spanning from 1895 to 2010.

HOW TO MANAGE FOR FUTURE DROUGHT STRESS?

- *Plant:* native species, seed sources local to your region, and species adapted to the various conditions and microclimates (soils, aspect, sun or wind exposure, etc.) at your site. For example, within a site you may have the option to plant Douglas-fir in draws or at higher elevations and plant Willamette Valley pine in the low, dry spots. Do not continue to replant with species that are struggling to survive or naturally regenerate.

- *Maintain:* thin trees early and leave enough space between trees to handle future droughts, reduce competition from other competing plants especially grasses and invasive species, and do not fertilize during droughts (increased growth increases moisture requirements).

- *Prevent and control:* be aware of the major insects and diseases that occur in your tree species and in your region and follow management guidance. Remove weak, injured or extremely stressed trees that may risk spreading insects and diseases to healthy trees.

WRCC temperature & precipitation maps
https://tinyurl.com/droughtmap-noaa

NOAA monthly drought report
https://tinyurl.com/drought-report

NRCS soil layers
https://websoilsurvey.nrcs.usda.gov/app/

TREE DECLINES

Declines are common in some tree species due to specific causes but in others there is no consistent factor or combination of factors that are a proven cause. Some declines have been on the rise in recent years and are potentially exacerbated by drought, although that is not always the case. Monitoring and assessment of dieback for causal agents in some of these tree species is ongoing.

Western redcedar has been declining in some areas from Oregon through western Canada. Symptoms may include yellowing needles, thinning canopies, topkill and branch flagging. Often these declining trees have sufficient access to moisture and are growing at sites thought to be appropriate for redcedar. Redcedar is fairly resistant to insects and disease and those that are present are typically secondary pests that infest already dead and dying trees. ODF and OSU are working on a reporting system to identify distribution and spread of this decline, as well as establishing monitoring sites to identify initial symptoms, patterns and potential causes.

Figure 8. Yellowing (left) and thinning crowns (right) in declining western redcedar (C. Buhl, ODF).

Bigleaf maple is a fairly drought-resistant tree that is showing dieback and leaf damage in various locations in western Oregon. Investigations by ODF and USFS have yet to determine the cause(s) although several isolated diseases and potential insect vectors may be contributing to damage.

Figure 9. Top dieback (left) and leaf 'burn' (right) in declining bigleaf maple (Wendy Sutton, OSU).

Grand fir, often larger trees, tends to struggle in the Willamette Valley. Large trees suddenly turn red and closer inspection reveals bark sloughed off by woodpeckers and fir engraver bark beetle galleries. Fir engraver is often suspected as the primary culprit, although healthy true firs frequently survive attacks from this insect. It is suspected that specific microclimates where these trees are growing are simply too dry to sustain active growth of large trees. Sometimes even few hundred feet variation in elevation can alter the microclimate enough to improve suitability for the growth of grand fir.

Figure 10. Topkill (left) and fir engraver galleries (right) in declining grand fir (C. Buhl, ODF).

ODF tree decline fact sheet series
http://tinyurl.com/odf-foresthealth

FIRE

2018 was another big fire year for Oregon (Fig. 13, map on next page). Across all ownerships a total of 883,300 acres (Fig. 12) were damaged by fire - well above the 10-year average for fire damage (547,300 acres). The number of human-caused fires and acres of subsequent damage were up about 40% from 2017. Although the number of lightning-caused fires was down by 40% from 2017 the number of acres damaged was up about 20%. On ODF lands, aggressive initial attack kept 93% of the fires at less than 10 acres. At the peak of the season 8,000 firefighters from all agencies (including 900 National Guard members) battled wildfires in Oregon. Suppression costs across all jurisdictions totaled approximately $708 million dollars.

Southwest Oregon suffered a complex of fires, including dozens ignited by lightning on July 15. The largest was the Klondike Fire, a FEMA fire that totaled 142,900 acres. These fires resulted in extremely poor air quality (Fig. 11) for weeks across half of the state. Fire severity has increased in the past several years largely due to extremely dry conditions that allow fuels to cure and quickly catch fire upon ignition. Governor Brown has created a committee to evaluate how Oregon responds to large fires but, due to ongoing droughts, intense and enduring wildfires are expected to continue.

Figure 11. Smoke from the human-caused Wilson Fire south of Heppner (Morgan Dally, OSU).

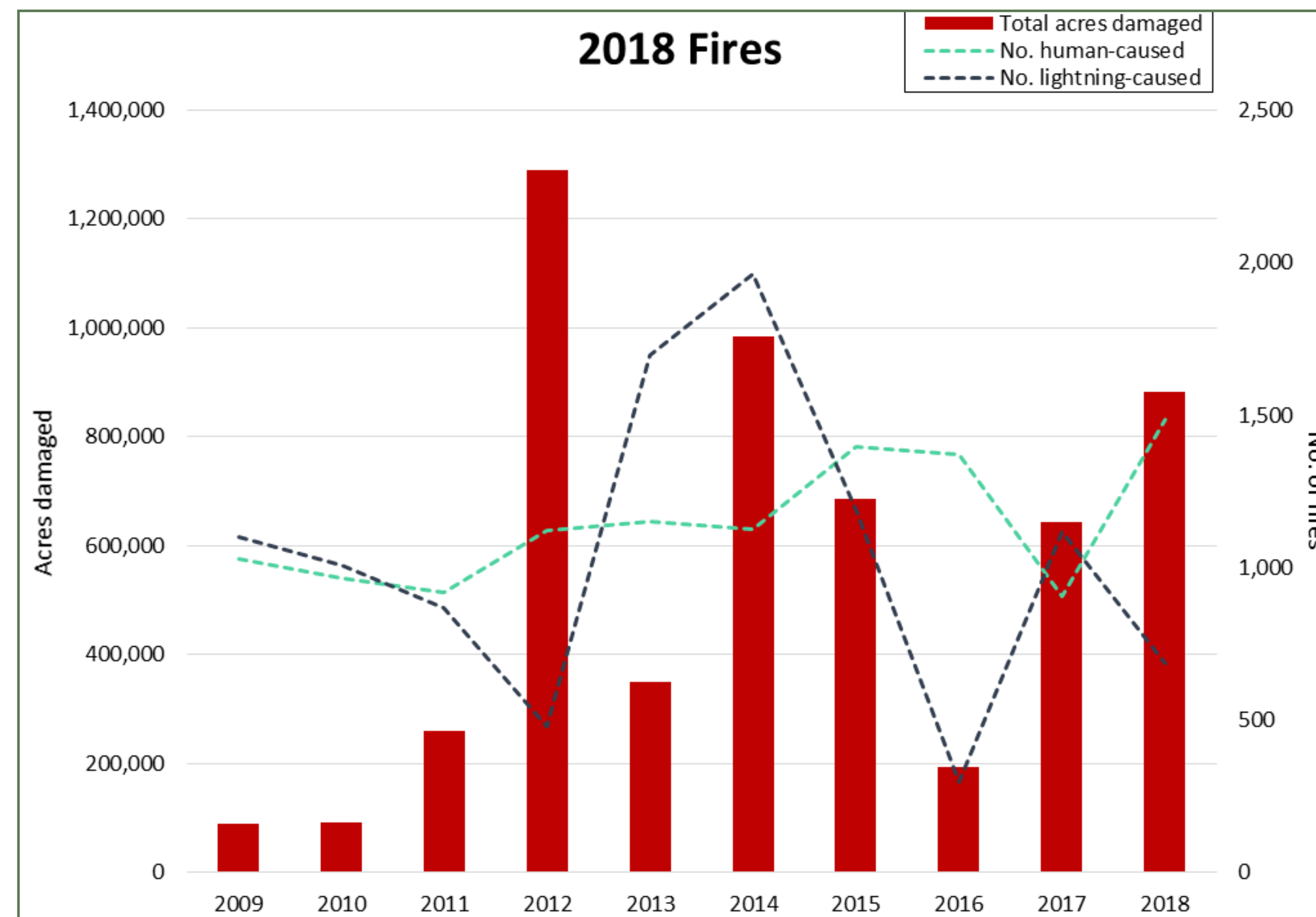


Figure 12. 10-year trends, across all ownerships, in annual number of acres damaged by fires, and number of fire starts from human (green) versus lightning (blue) causes.

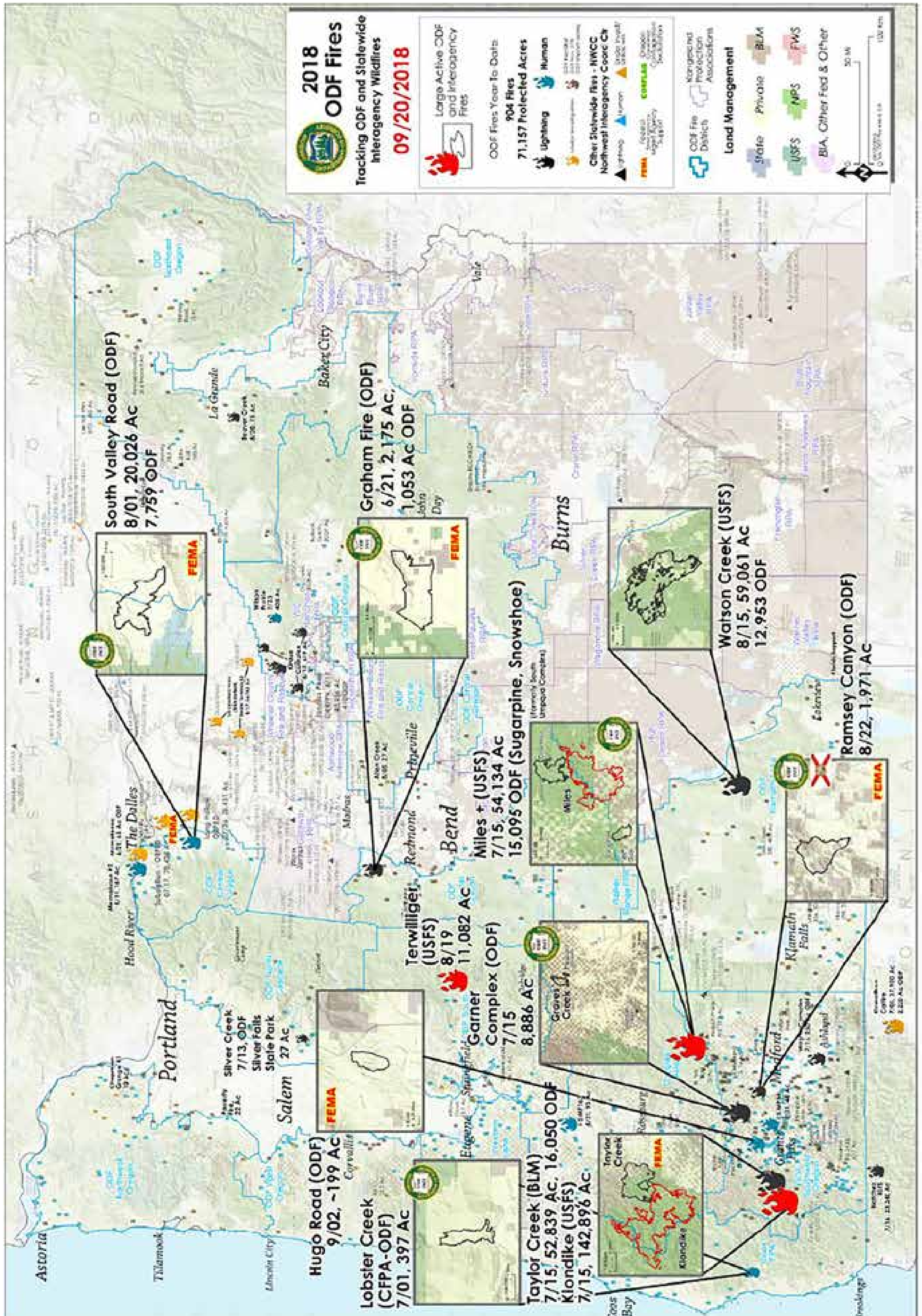


Figure 13. 2018 fire map of major incidents across all ownerships (TZA, ODF).

Figure 14. Images from the lightning-caused Little Rail fire near La Grande (Morgan Dally, OSU).

Oregon firefighters also assisted with late season fires that ravaged California well into October of 2018. Wildfire personnel are often called to assist with natural disasters in other states whose resources are exhausted.

YOUNG CONIFER MORTALITY

Impacts of early stand mortality can be significant. Losing young trees can have long-term effects by reducing growing stock, decreasing the wood fiber accumulated, reducing carbon stores (an area of increasing interest), altering target stand rotation dates, and ultimately presenting significant economic losses.

ODF and the USFS began to conduct aerial surveys to target damage to young stands in 1988. The target survey area focuses on the west side of the state because it contains the majority of industrial and private ownerships. Originally these surveys focused on issues related to bark peeling by black bears but in more recent years the impact of drought stress and root diseases, among other stressors, have been identified at the same time. There is anecdotal evidence that the area impacted by black stain root disease has been increasing in recent years. If true, this could increase the amount of young conifer mortality. Additional field work and studies are ongoing and may shed some light on this interaction and provide guidance on management strategies to reduce mortality in the young stand.

In the 2018 young conifer aerial survey, observers mapped just over 15,000 acres of damage. This was below the current 10-year average of about 30,000 acres. Damage to young conifers that is visible from the air seems to follow a cyclical trend that peaks roughly every ten years. Although only speculative, young conifer damage has been observed to increase following drought years and then decline. Peaks were observed in 2003, 2007, and 2015; all years following drought periods. Total young conifer damage tends to be highest on industrial lands due to stand management that generally favors younger stands. In 2018 damage decreased on state and industrial lands and slightly decreased on federal lands, but increased over the previous year on small non-industrial lands (Fig. 15).

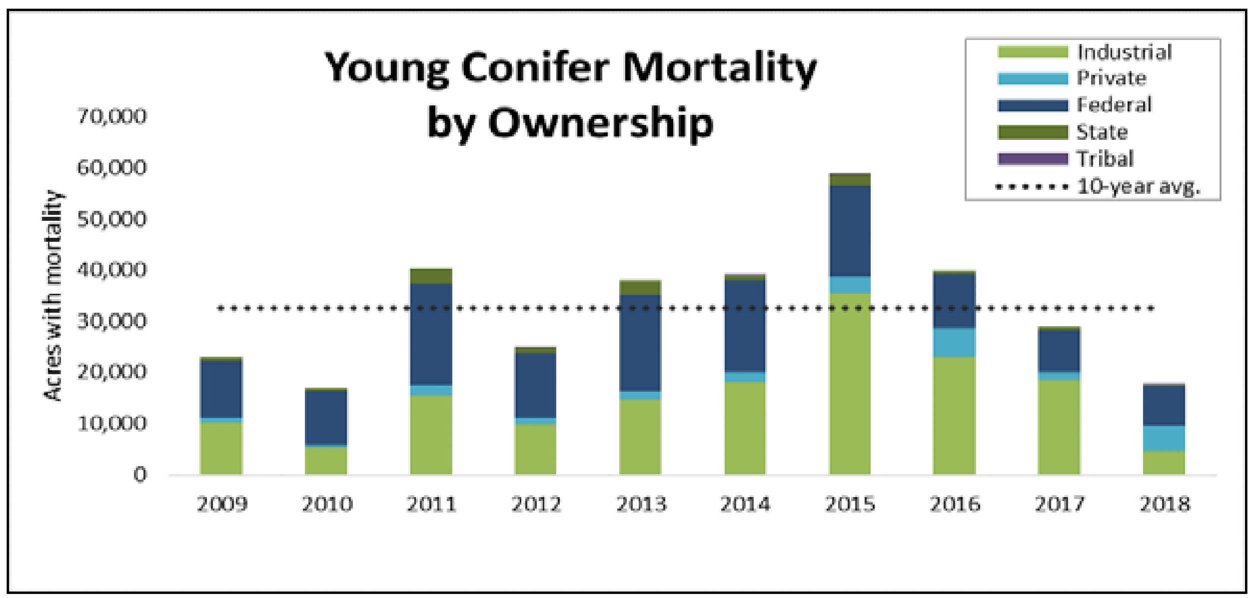


Figure 15. Young conifer morality has historically been highest in federal and industrial ownerships

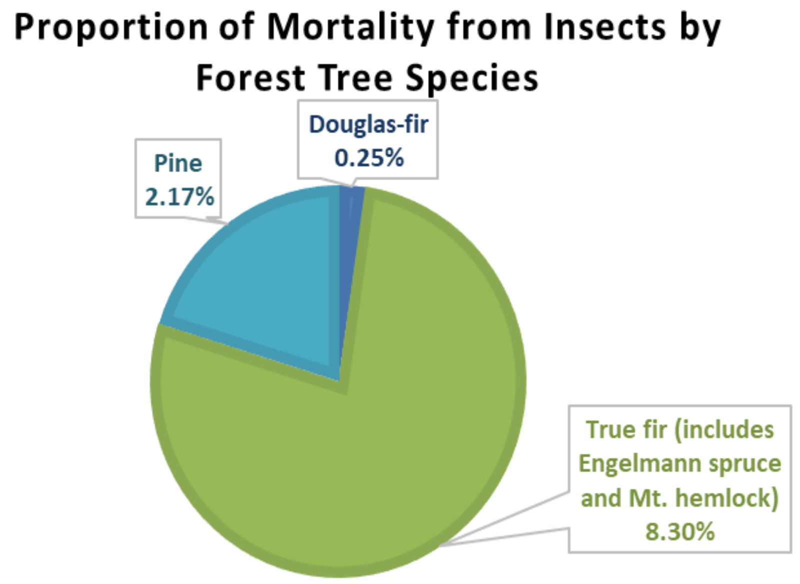
So why "young conifer mortality" and not "bear damage"? Historically, most of the damage associated with young conifers was attributed to black bears. It has become evident that there are more agents at work (such as the aforementioned black stain) in these dynamic stands and that attributing all the damage to black bears is inappropriate. This shift in language will hopefully reinforce that young forest stand health has many different considerations, and management should not focus solely on animal damage. The amount of young conifer mortality may shift, as the climate that they are growing in is shifting, which may predispose trees to drought stress and historically less important insects and diseases.

FOREST INSECTS

In 2018, Oregon statewide aerial surveys detected approximately 643,700 acres with damage or mortality from forest insects, which represents over *90%* of the total acres of forest damage detected in aerial surveys.

BARK BEETLES

The majority of detected tree damage and mortality was from bark beetles attacking Douglas-fir, pine and true fir (see chart at right). Once bark beetles enter trees nothing can be done to remove or kill them. When trees are stressed, opportunistic bark beetles will move in to take advantage of a weakly defended tree. During droughts, trees are especially at risk because they do not have enough moisture to produce pitch, which is a physical and chemical barrier to insects. Stressed trees will also release volatile chemicals that are attractive to bark beetles, allowing them to hone in on weak trees.



*TREE SPECIES COVERAGE FROM 2001-2010 FIA DATA

Figure 16. Reddish-brown frass on bark is the first indicator of bark beetle attack (left), not to be confused with white frass from woodborers which are often secondary (right) (C. Buhl, ODF).

ODF provides a 50/50 cost share incentive program from USFS funds with which landowners can get assistance managing for bark beetles
https://www.oregon.gov/ODF/AboutODF/Pages/GrantsIncentives.aspx

WOODBORING INSECTS

Once trees are dead or dying, various woodboring beetles may move in to continue the decomposition process. Most woodboring beetles are not tree killers because they bore into wood rather than feeding in and girdling vascular tissues. However, the **flatheaded fir borer** (*Phaenops drummondi*) is a woodboring beetle that behaves like a bark beetle and girdles trees under the bark rather than drilling into the wood. The most common sign of flatheaded fir borer infestation is bark flecked off by woodpeckers looking for beetle larvae (Fig. 17 Flatheaded fir borer attacks in Douglas-fir but can be hard to identify as the primary agent killing trees because Douglas-fir is also susceptible to drought, Douglas-fir beetle and various pathogens.

Figure 17. Douglas-fir infested by flatheaded fir borers, and bark flecked off by woodpeckers (C. Buhl, ODF).

SAP-SUCKING INSECTS

The second major pest to forest trees was **balsam woolly adelgid** (*Adelges piceae*) (Fig. 18), which is an exotic invasive insect from Europe that is firmly established in Oregon and spreading, particularly in true fir in the Cascades (Fig. 19). These insects are mostly stationary therefore spread is relatively slow. However there are limited natural controls and treatment is not feasible in most infestation areas therefore infestation continues to spread.

Figure 18. Balsam woolly adelgid (Elizabeth Graham, USFS).

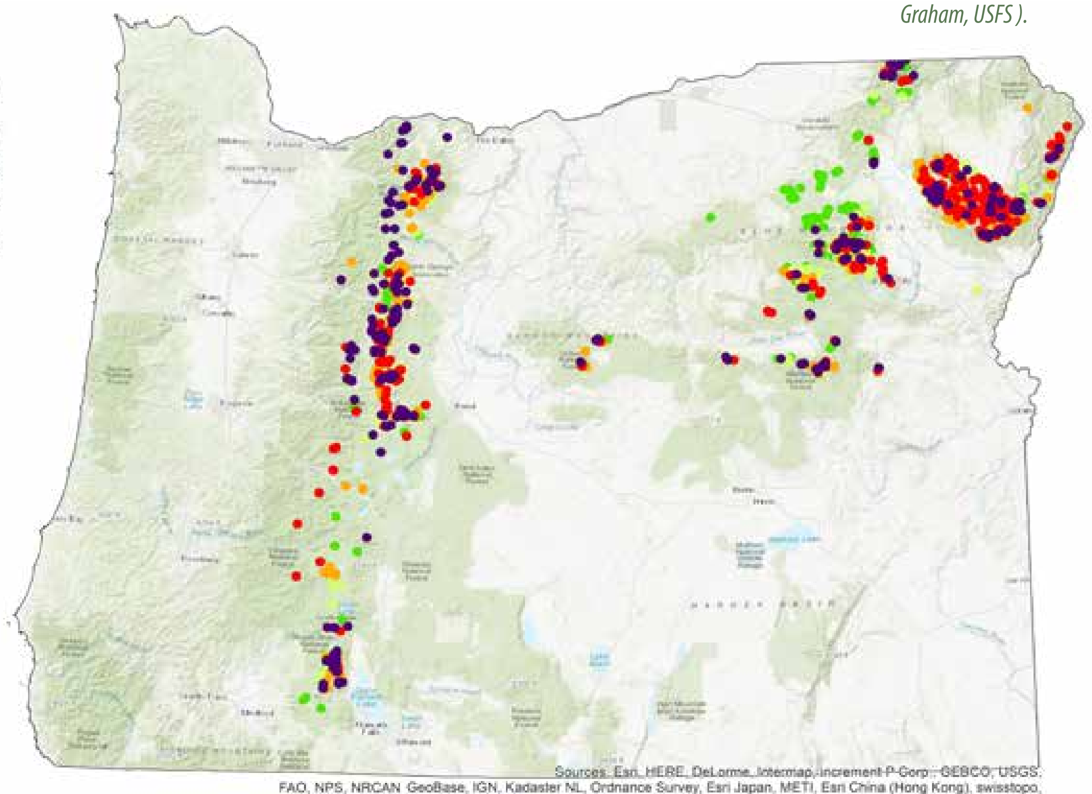


Figure 19. This map of balsam woolly adelgid-caused damage and mortality observed over the past 5 years indicates expansion and spread in the Cascades and NE Oregon (M. Lathrop, ODF).

DEFOLIATORS

The major defoliators observed in 2018 were Pandora moth in central Oregon, Douglas-fir tussock moth in the northeast, and alder flea beetle in central Oregon and along the coast.

Pandora moth (*Coloradia pandora*) has a two year life cycle and 2018 was the larval (feeding) stage (Fig. 20). The caterpillars then pupated underground and will emerge as adults in 2019. Approximately 145,000 acres of of pine damage from Pandora moth was mapped by aerial survey in 2018. This outbreak is suspected to have started in 2015, although it may have started earlier and gone undetected. 2019 is suspected to be the start of the second generation. There are typically 3-4 generations before a Pandora outbreak collapses, which means populations may subside in 2020 or 2022, if not earlier. As with many insects, outbreaks often collapse on their own due to disease, parasites, and dwindling resources, therefore control is often not necessary. Outbreak reoccurrence for Pandora moth is highly erratic with records indicating a reoccurrence anywhere from 9 to 156 years. Oregon's last outbreak ended in 2004. Because this insect feeds every other year, pines often rebound in non-feeding years. During drought pines may be less equipped to tolerate this compounded stress.

Figure 20. Pandora moth larvae feeding on pine needles in central Oregon (Robbie Flowers, USFS).

Douglas-fir tussock moth (*Orgyia pseudotsugata*) has been monitored in annual trapping surveys (Fig. 21) since 1979 in Oregon and Washington. Traps are baited with pheromone lures indicating when there is a rise in adult populations. High trap catches do not guarantee subsequent outbreaks or indicate specifically where outbreaks may occur but do alert us to start looking out for the start of potential defoliation events. In 2018, aerial surveys identified about 9,400 acres of Doug-fir tussock moth (DFTM) caused defoliation in NE Oregon which was confirmed by ground review. Total acres damaged by DFTM are likely higher because development of this defoliation does not always align with survey timing and not all areas are ground-checked. Outbreaks from this insect typically occur in pure stands of Douglas-fir and true fir, particularly along stand edges, ridges and harsh sites. Outbreaks of DFTM occur about every 7-10 years and can last for about 3 years.

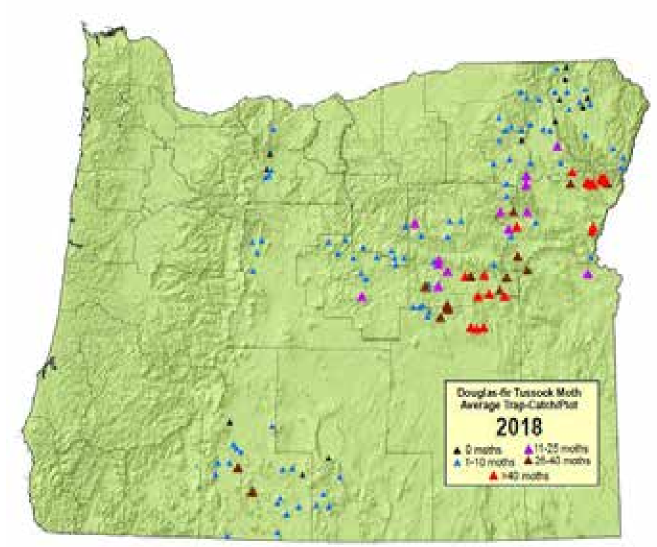


Figure 21. DFTM trap results in 2018 (Zack Heath, USFS).

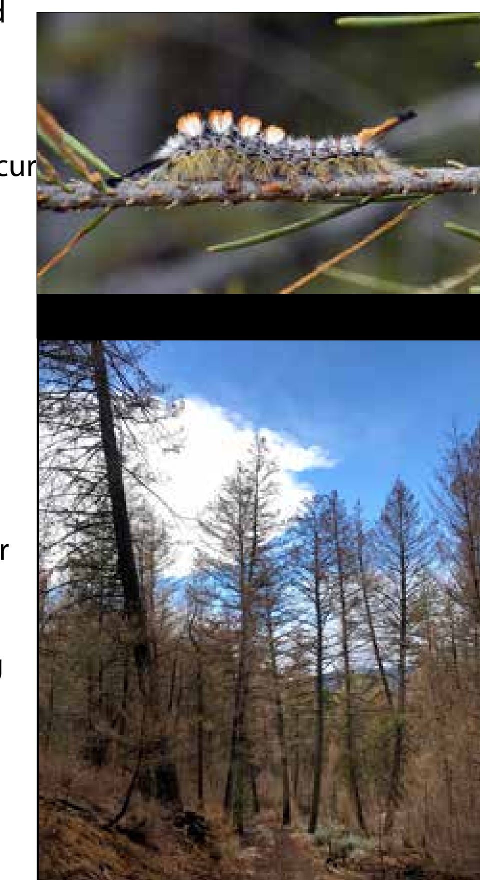


Figure 22. DFTM larvae (top) and defoliation (bottom) (C. Buhl and Jana Peterson, ODF).

Alder flea beetle (*Altica ambiens*) (Fig. 23) caused noticeable defoliation of red alder along the coast and thinleaf alder in central Oregon. Both the larvae and adults feed on foliage. Damage often starts with light scraping of the top layers of leaf tissue and advances to consumption of the tissue between leaf veins. Because these insects do not affect buds and do not exhibit large-scale outbreaks, alder will typically flush new leaves as normal following defoliation.

Figure 23. Alder flea beetle larvae (Robbie Flowers, USFS).

ODF fact sheets and diagnosis videos for these insects and more
http://tinyurl.com/odf-foresthealth

WHAT'S A PEST AND WHAT'S NOT?

How to distinguish between *bark beetles,* which tend to be more damaging, and the often less damaging *woodboring beetles* such as ambrosia beetles, roundhead and flathead beetles:

Bark beetles are the size of a grain of rice. First indictors of attack are reddish brown frass (boring dust, Fig. 24) and pitch streams or tubes. When bark beetles exit trees they leave behind holes the diameter of a grain of rice (Fig. 24). These beetles spend most of their lives under bark and do not tunnel into wood.

Often woodboring beetles are insects that do not kill trees but move into dead and dying trees to initiate the decomposition process. They can be distinguished from bark beetles in that they are often larger, some have long antennae and striking colors or patterns. Also, unlike bark beetles, woodborers actually bore into wood rather than just residing under the bark.

Figure 24. Reddish-brown boring dust (frass) is from bark beetles and white is from woodboring beetles (left), larger exit holes from woodboring beetles and smaller holes from bark beetles (right) (C. Buhl, ODF).

Exceptions to these woodborer 'rules' include flatheaded fir borer and ambrosia beetles. Flatheaded fir borer behaves more like a bark beetle in that it does not enter the wood and it can kill stressed trees. The most obvious indication of attack from this beetle is flecking of bark on Douglas-fir (see Fig. 17 in flatheaded fir borer section) by woodpeckers in search of grubs, which exposes lighter colored patches of bark along the trunk. Ambrosia beetles are borers but are also tiny, like bark beetles, and although they tunnel into wood like most borers, they do not feed on wood. Ambrosia beetles feed on fungus that they introduce and grow in their tunnels.

Figure 25. Tiny, c-shaped bark beetle larva (red cricle) relative to larger roundheaded and flatheaded woodborer larvae below (left). Rice-sized bark beetle adult (red) and also tiny ambrosia woodborer adult (purple) relative to larger, flashier woodborer adults (green) (C. Buhl, ODF and Steve Valley, ODA).

FOREST BEES

Oregon has over 500 species of bees, most of which are ground and cavity nesting. Recent research from OSU (Rivers et al. 2018, Galbraith et al. 2019) has shown a high abundance of bees in forests with high levels of disturbance by fire or harvest operations. This disturbance both exposes bare soil that bees use for nesting and increases light which promotes the germination of flowering plants. Native bees in forests has become a hot topic and Oregon is leading the way, via the Oregon Bee Project, in enhancing bee health and habitat and engaging the public.

Figure 26. Bees can be found foraging on flowering plants in forest understory or along edges (left), or nesting in the ground (center) wherever there is exposed soil such as slash burn piles (right) (C. Buhl, ODF).

The Oregon Bee Project led by OSU, ODA, and ODF is tasked with these objectives:

1. Protecting bees from pesticide exposure
2. Increasing bee habitat
3. Reducing impacts of diseases and pests
4. Expanding our understanding of the bees of Oregon

These objectives are being met by:

- ***Trainings*** for pesticide applicators on avoiding bee toxicity, the "How to Reduce Bee Poisoning from Pesticides" app to search for toxicity of active ingredients, and various bilingual publications on avoiding bee toxicity
- ***Developing guidelines*** for enhancing habitat based on current research, working with industry and small woodland owners, to establish habitat plots
- ***Research*** by OSU to better understand and protect against diseases and parasites
- ***Development of identification keys*** by OSU and ODA, cross-agency (OSU, ODF, USFS) research collaborations to assess which pollinators occur where and what forest plants they utilize most

Get involved!
https://www.oregonbeeproject.org/

Join the Oregon Bee Atlas
(Citizen science effort to find and identify bees)

Listen to the pollination podcast

FOREST DISEASES

NON-NATIVE DISEASES

Phytophthora ramorum is an invasive non-native pathogen that causes the **sudden oak death** (SOD) disease in tanoak (Fig. 27). SOD was first discovered in the 1990s in northern coastal California, where the disease has since spread to 15 counties. *P. ramorum* was discovered in 2001 in Curry County, Oregon and immediately an interagency program formed with the goal of complete eradication.

Figure 27. Bleeding cankers (left) and stem lesions(right) are some of the signs of SOD in tanoak (C. Buhl, ODF).

Spread of *P. ramorum* is managed through the designation of a SOD quarantine area under the authorities of the Oregon Department of Agriculture (ORS 603-052-1230) and the U.S. Department of Agriculture Animal Plant Health Inspection Service (7 CFR 301-92) (Fig. 28, map on next page). These state and federal quarantines regulate the intrastate and interstate movement of host plant material outside of the quarantine area. Oregon regulations require infested sites outside of the Generally Infested Area (GIA) on state and private lands to undergo eradication treatment. Since 2001, approximately 6,900 acres have been treated to eradicate *P. ramorum* and slow its spread. Treatments include cutting and burning infected host material and exposed hosts. Recent developments for Oregon's SOD Program include studying the effects from the Chetco Bar Fire, continued detection of EU1 infestations, and new outreach and education materials available for local small woodland owners.

In 2017, the Chetco Bar Fire burned approximately 191,000 acres including 94,746 acres of the SOD quarantine area and 4,598 acres of the GIA. During fire operations, ODF and USFS Pathologists were consulted by resource advisors on sanitation procedures and quarantine rules and boundaries to mitigate the risk of spreading SOD during firefighting activities. The fire burned through 19% of the SOD infestations detected in 2014 to 2017. According the USFS Burned Area Emergency Response soil severity data, 22% of the infestations were moderately burned and the remainder were either low or very low in burn severity. As part of a USFS Evaluation Monitoring Project, soil and vegetation samples have been collected from six of the burned SOD infestations with more sample collections scheduled for 2019. Preliminary results indicate that *P. ramorum* is still present on a portion of the burned sites. *P. ramorum* was detected on vegetation in four of the six sampled sites and from soil in three of the sites. The fire may affect future SOD aerial survey results, especially along the edges of the fire perimeter, where it may be hard to discern if tanoak mortality is due to the fire or SOD.

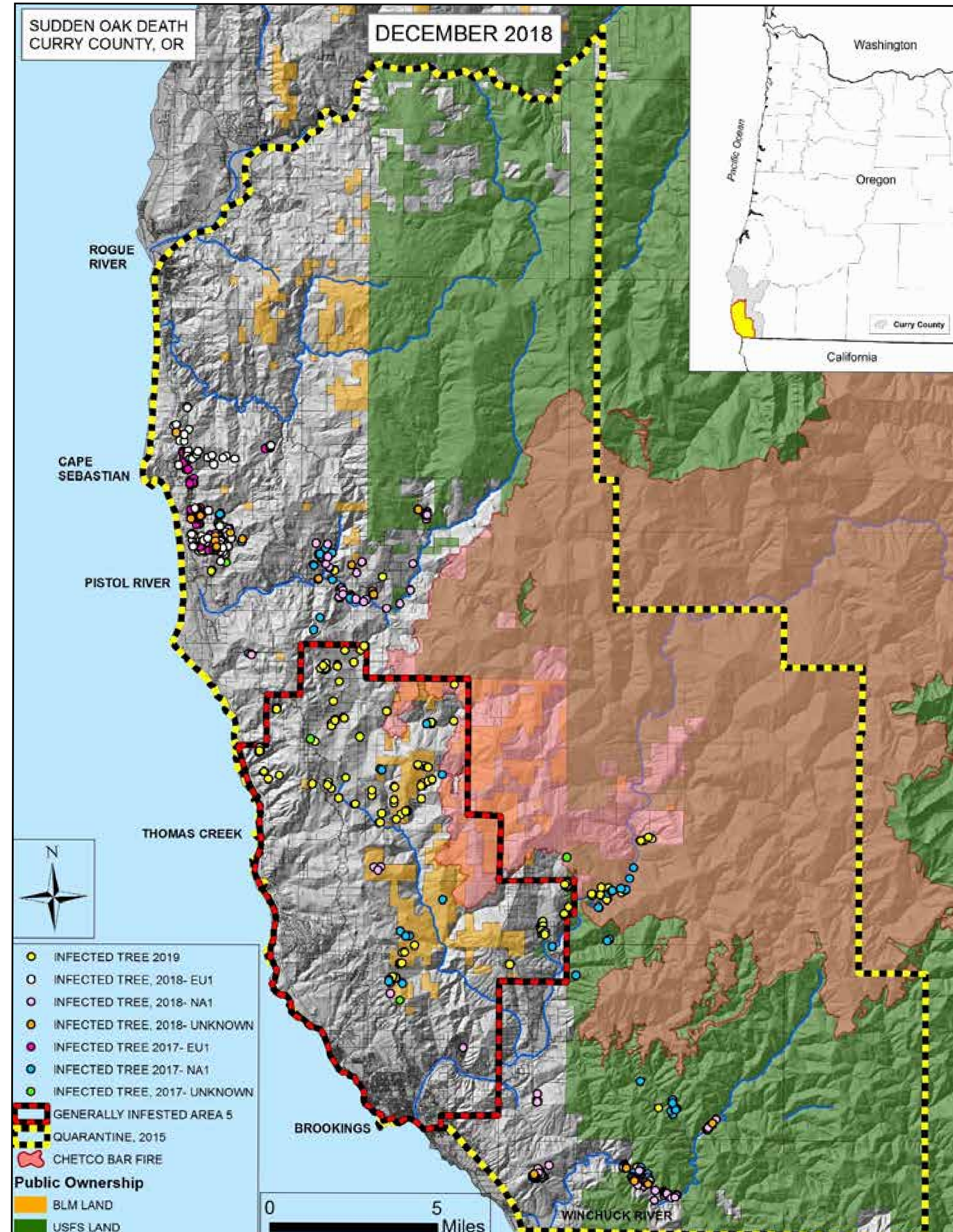
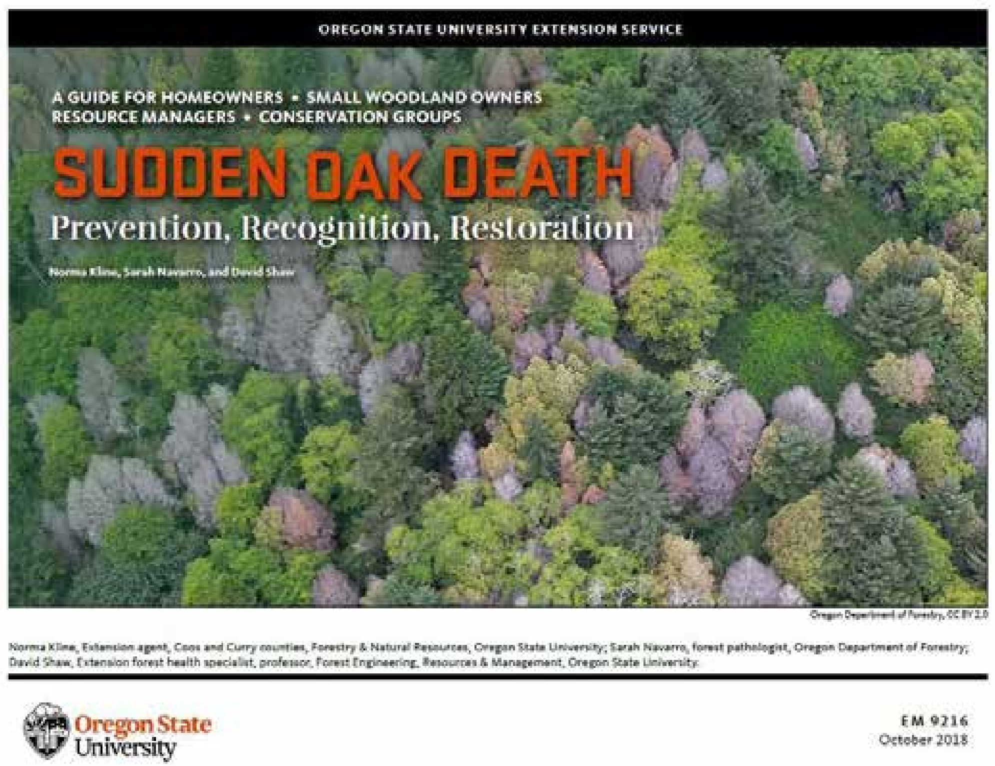


Figure 28. Map of SOD infection area (red) and quarantine area (yellow) (S. Navarro, ODF).

In early 2015, another lineage of *P. ramorum* (EU1) was detected on a single tanoak tree near the Pistol River on non-federal land. This is the first report of the European (EU1) lineage in US forests. Genetic analysis suggests a nearby private nursery (now closed) as the probable source. This finding is of particular concern because in Europe, the EU1 lineage kills or damages several conifer tree species and is considered more aggressive than the North American lineage (NA1). Since 2015, ODF has been aggressively treating all known EU1 infestations including large buffers of 300 to 600 feet. Eradication treatments for EU1 infestations totaled 270 acres in 2017 and 203 acres for 2018. Treatments are underway or planned on the remaining 455 acres of EU1 infestations detected in 2018 with more surveys on-going.

OSU Extension Service has recently published a new guide for homeowners, small woodland owners, resource managers, and conservation groups to recognize, prevent, and manage Sudden Oak Death. The guide is a resource for landowners that currently have SOD affecting their property and landowners that are not affected by SOD but could be in the future. The guide is available for free and can be downloaded here:

https://catalog.extension.oregonstate.edu/em9216



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

NEW! Learn how to diagnose, report and manage SOD
https://learn.extension.org/events/3581

FOLIAR DISEASES

Swiss needle cast (SNC) is caused by the native fungus *Phaeocryptopus gaeumannii* and affects only Douglas-fir. Symptoms are yellowing and premature needle loss (Fig. 29).

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.

Figure 29. Foliage loss from SNC in Douglas-fir (S. Navarro, ODF).

SNC is present wherever Douglas-fir grows but has become particularly damaging to Douglas-fir forests on the western slopes of the Oregon Coast Range. Fig. 30 shows the trend in damage from 1996 through 2018. The 2018 survey showed a slight decrease in the area of forest with symptoms of SNC compared to the previous six years. In the 2018 survey of the Cascade Range (Lane, Linn, Marion, and Clackamas Counties), 7,219 acres of moderate SNC symptoms were detected.

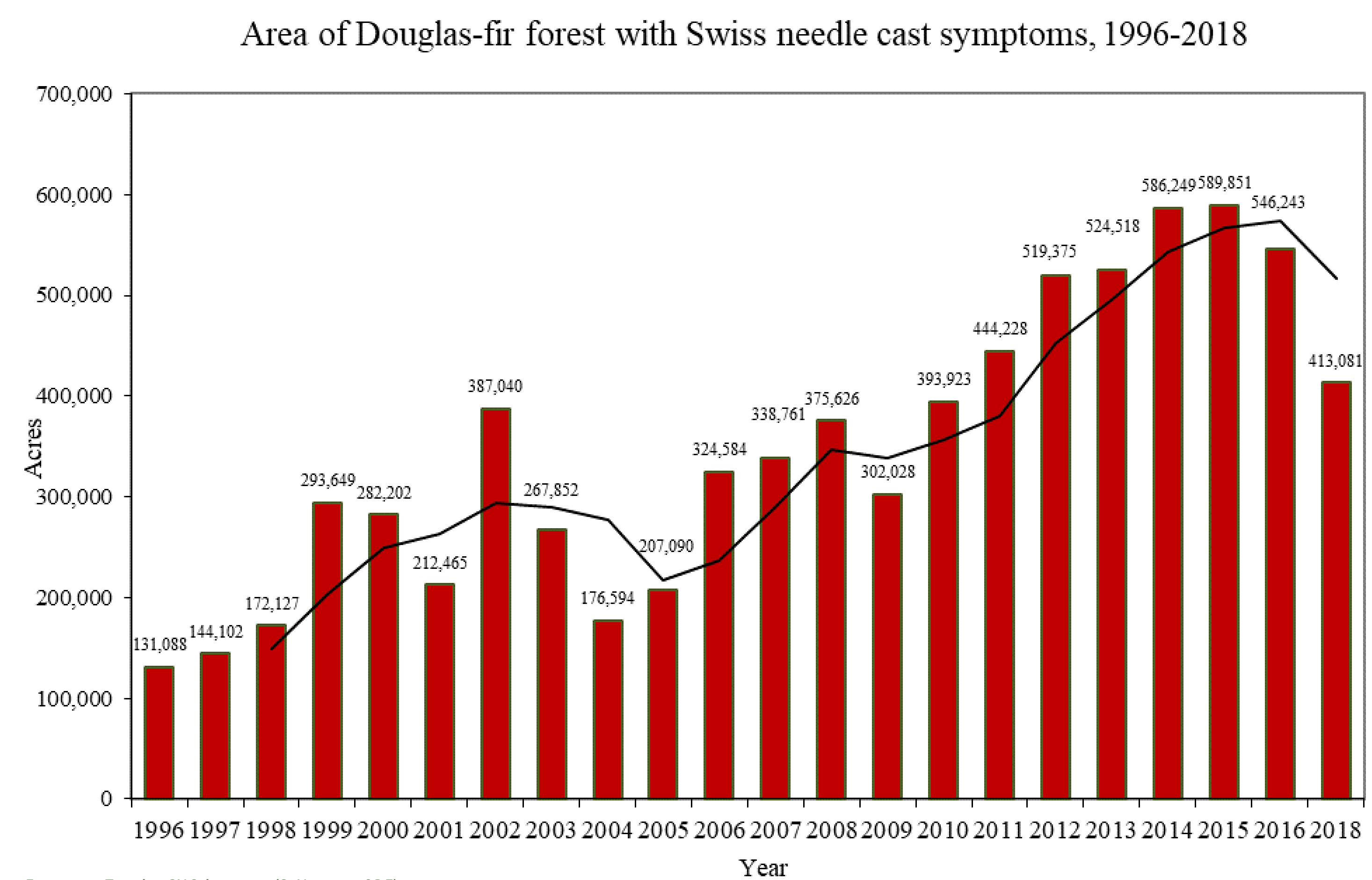


Figure 30. Trend in SNC detection (S. Navarro, ODF).

The 2018 SNC aerial survey, which is now conducted only in 'even' years, was flown in May and June to detect and map the distribution of SNC damage (Fig. 31). The 2018 survey covered 3.3 million acres in the Coast Range, and recorded 413,081 acres of Douglas-fir forest presenting SNC symptoms. Most damage occurred within 18 miles of the coast, although damage extended 28 miles inland along the Highway 20 corridor. In 2018, as in 2016, 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 1,860 acres, mostly in the Port Orford area, presented symptoms of SNC which is a slight increase from 2016.

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.

Swiss needle cast information
http://tinyurl.com/odf-foresthealth

http://sncc.forestry.oregonstate.edu

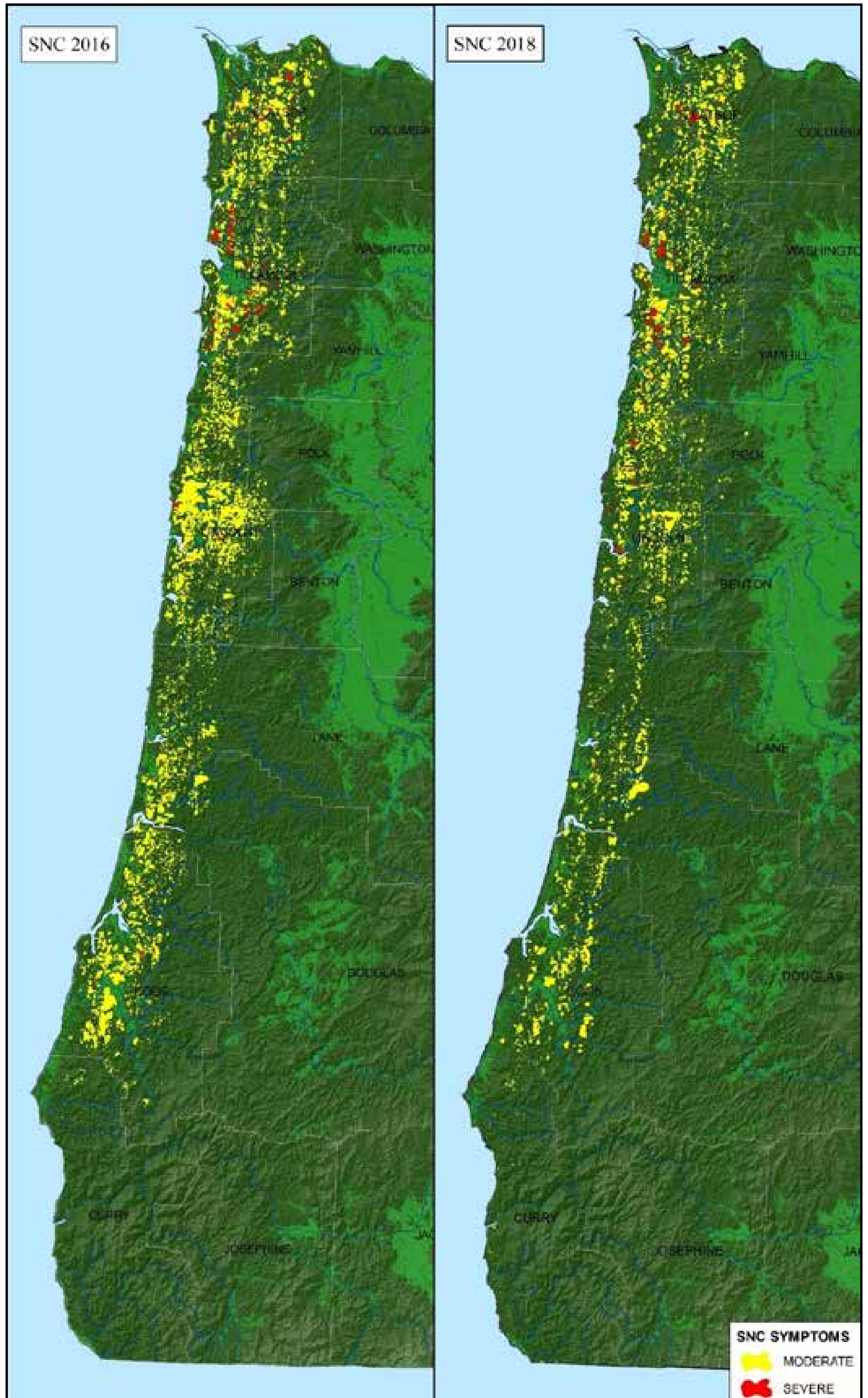


Figure 31. SNC distribution in 2016 and 2018 (S. Navarro, ODF).

ROOT DISEASES

Unlike the other native root diseases in Oregon, **black stain root disease** is caused by a tree-killing vascular wilt-type fungus (*Leptographium wageneri)* (Fig. 32), 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.

Observations during 2014 and 2015 suggest that the disease may be increasing in several parts of the Oregon Coast Range. In 2018, ground 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 (BSRD) was again detected in all stands that had been previously identified as having the infection in up to 5% of all Douglas-fir (Fig. 33). 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 BSRD because insect vectors are attracted to trees damaged by compaction and other stressors. However, BSRD also occurs on many stands located on slopes with no history of ground equipment use or compaction.

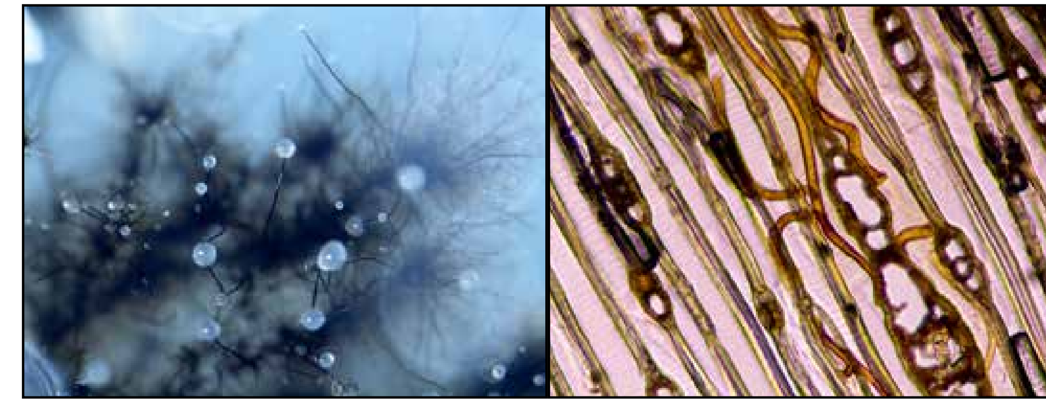


Figure 32. Black stain root disease fungal hyphae (left) and hyphae within tree tracheids (right) (J. LeBoldus, OSU).

In 2018, Oregon State University started a new research project to develop a better understanding of the epidemiology of BSRD through population genomics. The specific objectives are to:

Figure 33. Black stain root disease in young Douglas-fir (S. Navarro, ODF).

1) Analyze full-genome sequences from a population-level sampling of *L. wageneri* var. *pseudotsugae* to characterize reproductive biology, genetic diversity, and population structure of the pathogen, and

2) Infer the relative importance of local vs. long distance dispersal in the establishment of new BSRD infection centers. They hope the research will lead to the development of better BSRD management strategies.

INVASIVE SPECIES

OREGON FOREST PEST DETECTOR (OFPD)

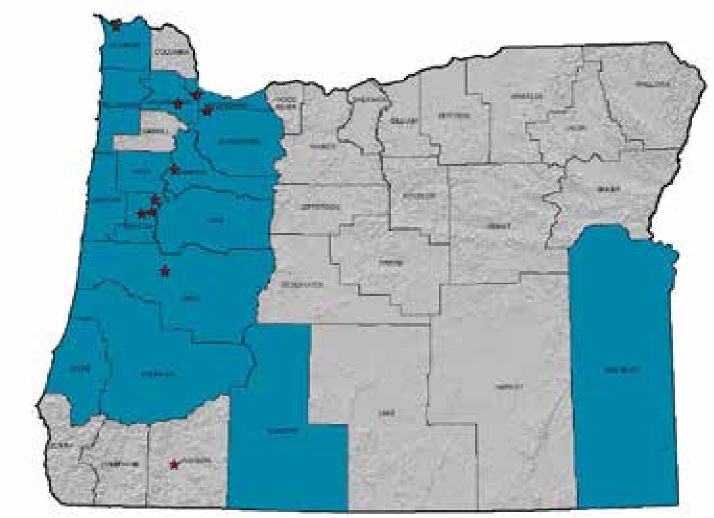


Figure 34. OFPD students from counties (blue) across the state have been trained at several field sites (redstars).

For the fifth consecutive year, ODF Forest Health team members served on the interagency Oregon Forest Pest Detector program. The USDA-funded OFPD, coordinated and led by Oregon State University Extension Forestry, trains 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 500 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 when eradication is still feasible.

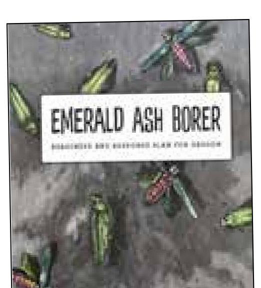
Oregon Forest Pest Detectors course information
http://pestdetector.forestry.oregonstate.edu/

EMERALD ASH BORER

Figure 35. EAB trap (W. Williams, ODF).

A cooperative statewide emerald ash borer (*Agrilus planipennis*) survey was conducted in 2018. Emerald ash borer (EAB) traps (Fig. 35) and lures were provided by USDA-APHIS with ODF coordinating the survey with local cooperators. Local government officials in Portland, Corvallis, Medford, Ashland, La Grande, and Bend, as well as the Confederated Tribes of the Grand Ronde, all participated alongside ODF and USDA-APHIS in placing EAB traps in Oregon. No EAB were detected in traps in 2018.

In March 2018, staff from the ODF Forest Health Unit, in conjunction with ODF Urban and Community Forestry Program, delivered a "Trees in Trouble" webinar for Oregon's communities to provide an update on emerald ash borer. The goal of the webinar was to better prepare Oregon's cities and towns for the arrival of emerald ash borer by advising community tree inventories, EAB risk assessments, and lessons learned from other communities across the United States.



In May 2018, ODF and ODA finalized the state's "Emerald ash borer readiness and response plan for Oregon" with assistance from local and federal cooperators and stakeholders. Oregon's EAB plan presents the risk of EAB to the state and advises how communities can prepare for the insect's arrival. The plan can be found on the web at www.oregoneab.info. In September, USDA-APHIS held a public comment period for a proposed rule change to eliminate the federal quarantine for EAB in the United States. Lifting the federal quarantine would likely accelerate the spread of EAB across the U.S. to un-infested states, such as Oregon.

GYPSY MOTH

Gypsy moth (*Lymantria dispar)* is an exotic insect that was introduced to Boston, Massachusetts in 1869. It has since spread to 20 states in northeastern U.S. and Canada. Several subspecies of gypsy moth (GM) occur across the world with the most common being the European GM (the only GM established in the U.S.) and the Asian GM (not established in the U.S.). GM has a very broad host range of over 500 species of trees and shrubs. Caterpillars prefer oaks and other hardwoods but have also been known to feed on conifers such as Douglas-fir. Over 80 million acres of forests in northeastern U.S. have been defoliated by GM since 1970.

Since 1979, Oregon has been 100% successful in detecting and rapidly responding to GM introductions in the state. The Oregon Department of Agriculture oversees gypsy moth surveillance and response. Oregon Department of Forestry assists with detection and eradication activities when requested. Between 10,000 and 20,000 gypsy moth pheromone traps (Fig. 36) are set annually in Oregon. A handful of GM are captured most years in Oregon. Investigations reveal that these GM originate from infested cargo and household relocations to Oregon from the northeastern U.S. (European GM) or from international vessels arriving to port in Oregon (Asian GM). Usually small incipient populations of GM disappear on their own but occasionally these populations require eradication treatments.

Figure 36. Gypsy moth caught in monitoring trap (C. Buhl, ODF).

In spring 2016, nearly 7,000 acres of urban forests in Portland, OR and neighboring Vancouver, WA, were treated with an aerial pesticide for GM following detections made in 2015. Subsequent trapping surveys inside the treatment area for three consecutive years (2016, 2017 and 2018) were negative for GM, indicating that the insect was successfully eradicated. In 2018, ODA reported the following adult GM collections in traps: 3 in Multnomah, 2 in Lane, 1 in Deschutes, 2 in Marion and 27 in Benton counties. In April-May 2019, ODA will address the Benton county population with a ground-based eradication project, because of the smaller tree overstory, on 46 acres of residential neighborhood in Corvallis. The pesticide selected for treatment is a naturally-occurring soil bacteria, *Bacillus thuringiensis kurstaki* or Btk, that breaks down quickly in the environment and has limited non-target impacts.

ELONGATE HEMLOCK SCALE

Figure 37. EHS on underside of fir needles (Eric Day, VPISU).

The elongate hemlock scale (*Fiorinia externa*) was detected in Oregon in 2018 on Fraser fir Christmas trees grown in North Carolina and shipped to various western states for sale. Elongate hemlock scale (EHS) originates in Asia but has been established on hemlock in the eastern U.S. since 1908. In addition to hemlock, this insect is known to feed and reproduce on Douglas-fir, spruce, true fir, pine and yew. Males have wings but are short-lived. Females are wingless and become established on trees. Their young disperse by crawling and blowing on wind currents. EHS can be found feeding on the underside of needles (Fig. 37) and yellow bands may appear on the top of needles. Heavy feeding can cause needle drop and suppress tree growth. People are advised to buy locally-grown Christmas trees and inspect Christmas trees for this pest. Suspected infestations should be reported to the Oregon Invasive Species Hotline or the Oregon Department of Agriculture.

INVASIVE WOODBORER SURVEY ALONG COLUMBIA RIVER

A special survey for exotic, invasive woodborers continued for a third consecutive year in 2018. The 3-year project is funded by the U.S. Forest Service Special Technology Development Program. The aim of the project is to test new commercially available pheromone lures in their ability to detect newly established, exotic wood-boring 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. At each site, eight unique pheromone lures were installed on funnel traps (Fig. 38) hung on rebar frames. The survey was conducted April to September in 2016, 2017 and 2018. The Oregon Department of Agriculture cooperates on the survey and provides sample processing and insect identification.

Figure 38. Woodborer and bark beetle trap (C. Buhl, ODF).

To date, over 100,000 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 over 25 exotic species recorded in the survey, most of which are long-term residents of Oregon. However, four new exotic species have been detected in project traps (Fig. 39):

1. an eastern U.S. flatheaded borer (*Chrysobothris rugosiceps Melsheimer*), June 2017, Longview, WA;
2. an Asian ambrosia beetle (*Cyclorhipidion pelliculosum* (Eichhoff), May 2017 and 2018 at Rooster Rock State Park, OR;
3. the European hardwood weevil, *Trypodendron domesticum* (Linnaeus), May 2018, Scappoose; and
4. an Asian ambrosia beetle (*Xyleborus monographus*) June 2018, Multnomah County.

Figure 39. (1) C. rugosiceps, (2) C. pelliculosum, (3) T. domesticum, (4) X. monographus (Steve Valley, ODA).

Of the four new exotic woodborers, the last one listed is most likely to cause harm to Oregon's native trees, namely Oregon white oak (*Quercus garryana*). Officials from the Oregon Department of Agriculture and the U.S. Forest Service and USDA-APHIS were notified. Further surveys are planned in 2019 to determine whether this particular insect has established in Oregon.

EXOTIC INVASIVE PLANTS

In 2018, ODF forest health staff provided technical advice on plant identification and weed management to several forest landowners and land managers. Following up on the first recorded occurrence in 2017 of **Orange hawkweed** (*Hieracium aurantiacum*) (Fig. 40) in Clatsop County, ODF Forest Health staff along with ODF staff from Clatsop State Forest conducted a delimitation survey for the noxious weed. During the spring months in 2018, the population was monitored on a regular basis until flowers began to appear in early July. The population appeared to be limited to less than 50 plants within two clumps, both less than 2 m^2. All flowers were clipped from plants, bagged and disposed before seed could be set. The plants were then spot sprayed with clopyralid. A survey of dozens of miles of forest roads in the area did not yield any further plants. Additional surveys for this plant will be conducted in 2019 in Clatsop State Forest. Orange hawkweed 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. 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).

Figure 40. Orange hawkweed (Jamie Nielsen, UA-Fairbanks).

Figure 41. Gorse in flower (left) and prior aerial survey of gorse (right) (W. Williams, ODF).

ODF Forest Health staff participated in steering group meetings for the Gorse Action Group (www.gorseactiongroup.org) in 2018. The objective of the group is to control and reduce the spread of **gorse**, (*Ulex europaeus*) minimize its impacts on the economy and environment, and to share lessons learned with others who are managing this noxious weed. A gorse removal demonstration project was completed in 2018 south of Bandon along a Highway 101 frontage road. Several different management tactics for gorse, including various chemical and mechanical treatments as well as burning, are explained to viewers who stop at the site.

Think you've spotted an exotic invasive?
Report it!
http://oregoninvasiveshotline.org/

FOREST HEALTH CONTACTS

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2600 State Street, Salem, OR 97310
http://tinyurl.com/odf-foresthealth

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Michael Jennings	Ecologist	541-962-8533	michael.jennings@usda.gov