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Northwest Woodlands

A Publication of the Oregon Small Woodlands, Washington Farm Forestry, Idaho Forest Owners & Montana Forest Owners Associations

FOREST HEALTH AND PESTS

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NEXT ISSUE . . . Thinning for the Health of Your Forest

This magazine is a benefit of membership in your family forestry association. Contact the officers listed on page 5 for membership details.

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Whitebark pine forest affected by white pine blister rust and mountain pine beetle.
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PRESIDENT'S MESSAGE

Montana

ALLEN CHRISMAN

Douglas-fir Bark Beetles in our Montana Forest

Bark beetles often exist at endemic levels in Montana forests.

But, in 2019, we discovered one of our large Douglas-fir trees had been successfully hit with Douglas-fir bark beetle. How did we know? Well, the first giveaway is the frass, or boring dust, caught in the bark crevices. That indicates successful beetle activity, as the adults burrow into the bark to get to the cambium to create their egg galleries. We confirmed the presence of the bark beetles and their identity by chopping off a strip of bark down to the cambium layer and found bark beetles, their gallery, and the first of the eggs they had deposited.

After the egg masses hatch into larvae, they burrow perpendicularly to the gallery and emerge as adults the following spring. The egg masses found in the early summer of 2019, would have emerged as adults in the spring of 2020. Later in 2019, we found some 22 Douglas-fir trees ranging from 11 inches in diameter to 39 inches in diameter that were successfully hit.

We had no way to remove the infested trees, so in the spring of 2020 we put out approximately 300 pheromone caps. We used double bubbles, which have twice the amount of pheromone as the single caps. Pheromone caps signal to the bark beetles as they emerge that "this tree is full, go find another one." In our case, because we had several large diameter "Legacy" trees, and a rich species mixture with Douglas-fir being represented in perhaps 10% to 30% of the stand, it was worth it for us to deploy the pheromone caps.

Bark beetle burrow tunnels.

Pheromone caps are available from Conservation Districts, some Arborists, and of course from the manufacturers. In our case, we used caps from a manufacturer—Synergy Semiochemicals Corporation in Canada—and used their "double bubble" caps. We used one cap per Douglas-fir 12" to 24" in diameter, and two for trees larger than 24". They are simply stapled to the north side of the tree's trunk. A nice feature of the caps is that the manufacturer produces them in different colors each year. The photo shows three years of pheromone caps on one of our Legacy Douglas-fir trees. Pheromone caps are not cheap—but they are effective. We suffered no more losses from Douglas-fir bark beetles after application in 2020. We deployed the same number of caps in 2021, and then in 2022, we reduced to about a third of our number, focusing primarily on Legacy Douglas-fir over 20" in diameter.

Pheromone "double bubble" caps on the north side of a Douglas-fir.

Annual monitoring of your stands, as well as being aware of new infestations around you, will give you time to respond to new outbreaks. It is nice to have this tool in our bag to dissuade Douglas-fir bark beetles. ■

PRESIDENT'S MESSAGE

Washington

DICK ALESCIO

Making a Plan to Safeguard Forestlands

There are several approaches to forest health for our woodlands. One approach is to do very little, just look at it and enjoy it. Another approach is to let whatever happens, happen and deal with the consequences when they arise. Folks have gotten away with that for decades. The other option is to have a managed forest in accordance with our vision for the land, which we formally describe in our "Forest Management Plan" and keep on file with the Department of Natural Resources and County, as required. As more counties require a forest management plan for forest tax status, this approach appears to be the most viable option to not only safeguard our forest lands but also to maximize our expected return on investment, when applicable.

Climate change requires us to be more mindful of wildfires than we have been. Dealing with this threat is now a consideration from the Pacific Coast until the forests run out in Montana and Idaho. Fortunately, the Department of Natural Resources (DNR), the Federal Natural Resources Conservation Services (NRCS), and conservation districts have mobilized programs and funding to help deal with forest health and wildfire threat.

These include:

Understory brush removal (to include "Mastication" or rough grinding wood debris then spreading it back on the ground to add nutrients to the soil).

Thinning to prevent tree crowns from touching. East of the Cascades, where there is less rainfall, thinning should be fewer than or equal to 300 stems per acre based on site productivity and stand density.

Pruning thinned trees up to 10-12 feet above the forest floor to eliminate a fire ladder from the ground to the tree crowns.

In the past, forest owner's left precommercial thinning on the ground to rot. We can no longer afford to do this because of fire hazards and insect infestation. We also left wood debris from commercial thinning and logging on the ground. Treatment of this wood waste requires chipping to a level of approximately 1/2 inch for soil nutrient purposes. The pulp mills and sawmills are always looking for wood waste for producing pulp chips or hog fuel for power boilers.

Our forests are home to a lot more than people. The deer browse "new plants" if unprotected. Bears like the bark on young trees, beavers and voles enjoy tree roots, and cougars like anything with red blood, but don't bother trees. In addition, root rot diseases and "rusts" can take a toll if we're not watching. This past summer and fall have been extremely dry for most of us. Lack of rain has stressed the trees making them less able to withstand disease and beetles. Watch the tree crown tops for defoliation and prematurely dead needles. The best plan of action if root rot, rust, or an infestation has occurred, is to isolate the problem, pile burn what you can, and switch to a different species on the next rotation. Depending on the situation, it may be wise to harvest earlier in the growth cycle, then switch species. Enjoy and be safe! ■

PRESIDENT'S MESSAGE

Idaho

J. FRANK MORADO

Reflections on the Stink Bug

Every year presents a different challenge concerning forest health and pests. This notion came to mind as I was measuring my response to this year's "stink" bug infestation and the factors leading to this nuisance.

Many physical and biological factors contribute to the range of interactions between different organisms. Disease researchers point to a simple disease model, expressed as the *"epidemiological or epizootiological triad"*, generally depicted as three overlapping circles symbolizing host, parasite/pathogen/pest, and environment. The point where all three circles overlap represents the likely occurrence of a disease or negative outcome. In truth, the model is overly simple, but it does present a starting point for examining the many interactive factors of the model. Population genetics, age structure, susceptibility, health, diet, and social events are only a few determining host elements. Influential parasite/pathogen/pest factors include virulence, generation cycles, resistance to control methods, and commercial transportation behaviors. With respect to the environment, we can start with climate and its associated features such as temperature, precipitation, and wind in relation to their spatial and temporal scale. The interactions and impacts of the noted factors are variable, generally resulting in complex additive, complementary or antagonistic effects. I generally describe the triad model as "plastic" because each factor's importance or contribution varies over time.

Like many landowners, I have noticed increased grand fir mortality, generally corresponding to periods of drought which do not favor grand fir health. Crowded growth conditions and root disease are additional health stressors. However, the same conditions that negatively affect grand fir, favor the development and reproduction of fir engravers such as members of the genus Scolytus. The long, hot, and dry summers promote rapid bark beetle development resulting in multiple generations and reducing the grand fir's ability to "expel" invading bark beetles.

A few years ago, my wife and I pre-commercially thinned our forest to decrease over-stocking and reduce fuel loads. The desired effects were achieved, but fir mortalities are still occurring, although at a reduced rate. Our next consideration is the complete removal of grand fir while enhancing the more common white pine, western larch, lodgepole, and ponderosa pine, but also improving the common Engelmann spruce, western hemlock, western red cedar, and Douglas-fir.

Getting back to our "stink" bug infestation. Two different bugs are trying to get into your house, one is the non-native stink bug. The other is the native western conifer seed bug which also stinks; it feeds on conifer cones and there is a bumper crop of grand fir cones this year. The absence of the western bluebird, a predator, has also contributed to the stink bug infestation. However, cold temperatures will eventually settle the issue for the year. ■

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PRESIDENT'S MESSAGE

Oregon

KEN NYGREN

Farewell and Welcome

This issue of *Northwest Woodlands* will be my last to write as a President of the Oregon Small Woodlands Association. In late September, the members of the association voted in a new President-Elect, Gordon Culbertson, and so Nicole Wood and I took one step to the left and I became the Past-President and Nicole assumes the mantle of President. It has been a roller coaster ride of events over the past two years, but also very fulfilling to be part of the strong leadership team and active membership of OSWA.

Western Oregon is currently experiencing several new challenges to forest health on top of the lingering effects of our drought (maybe related to the drought effects) which will challenge our small landowner community. The appearance of the dreaded Emerald Ash Borer as the latest imported threat to the Oregon ash trees has sent a shockwave through the Willamette Valley Forest landowner community. Bigleaf maple and Western red cedar are both showing signs of mysterious dieback throughout Western Oregon and Southwest Oregon. We also continue to have occasional outbreaks of the Oak Looper, Doug fir beetle, and Swiss Needle Cast which plague us. It makes you realize how stubbornly optimistic tree farmers are when they continue to plant trees and plan for future activities on their property.

Layering these forest health issues with transitioning new forest practice rules gives us reason to roll up our sleeves and get to work educating ourselves and practicing good forestry on our lands. The value of belonging to a community of fellow landowners will certainly show up as we gather to share our experiences and support each other as we muddle through. *—Ken Nygren*

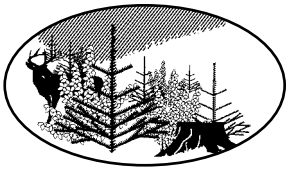
As Ken said, we each took a step to the left. I will be the OSWA president for the upcoming two years. I follow professional Foresters in this position however, my background is in the medical field. My love for small forest owners comes from my father, Leland Payne, and his family. Dad raised me on our homestead property where he continues to educate me about forest stewardship. My father is the third-generation owner of the property. I will be the fourth owner and third female owner. My father grew up on Green Mountain of the Yamhill Coastal Range. He has professionally logged since he was 12 years old.

Nicole Wood

For this article, I sat down with my father and asked "Dad, how do you look at forest health"? We talked about pests, such as insects, wildlife, and invasive foliage. Then we discussed the impact of weather. My father's property has areas that are suffering from moderate drought. This has been creating a cascade effect of trouble for the 15-acre section of seedlings and young trees. Since my father does not use chemical ground preparation, this compounds the struggle for the young trees. They not only endure the drought, but the brush, scotch broom, and blackberries choke the trees by absorbing nutrients and moisture the seedlings could be utilizing. Furthermore, the elk and deer are not interested in dry foliage, instead, they enjoy browsing the seedlings.

We paused to ponder what we had discussed thus far and then turned our talk to fire. Prescribed fire provides protection, but a wildfire is a swift devastation that creates a situation to reinvent forest health, if possible. Wildfire prevention and maintaining biodiversity are our top priorities. We have hope that if we maintain biodiversity and keep grooming the forest for wildfire prevention, we will be successful in our vision of forest health.

I look forward to more conversations with my father as we continue to learn about forest health together. I also look forward to sharing our discussions with *Northwest Woodlands* magazine. *—Nicole Wood* ■



Down on the Tree Farm

FEBRUARY

✓ Register for your association's annual meeting, conference, or tour: IFOA's conference is March 27-28 in Moscow; MFOA: look for the Montana Forest Stewardship Foundation's Forest Landowner Conference in Spring (April or May); WFFA will hold a large indoor event in June and OSWA will host the Family Forest Convention June 22-23-24 in Estacada and their annual meeting is October 10th, 2023. These events are one of the best benefits of membership—an opportunity to exchange success stories and challenges with your fellow forestland owners.

✓ Clean out and repair your bird boxes and perches; install new ones wherever you've seen recent activity. Raptors would appreciate a handy perch adjacent to your mouse, vole, or ground squirrel activity!

✓ Assemble pertinent tax records and prepare your return. If you are lucky enough to have an accountant or tax preparer, take your paperwork to them early.

✓ Research integrated pest management options for invasive plants or insect/disease issues in your forestland. Pesticides are sometimes the best solution, but they're not the only solution. Consult with your tree farm contacts for treatments that have been successful. Whenever possible, practice prevention.

✓ Where there is potential for pine engraver beetles to enter your thinning slash, complete your precommercial thinning early in the year so the slash has time to dry before the first flight.

✓ Tour your proposed logging operation with your forester and logger. Rely on their experience and good reputation to conduct a successful operation. Develop a solid contract and time your operation carefully. Take the responsibility to assure that your logger has all appropriate fire equipment in good working order.

MARCH

✓ Begin tree planting in higher elevation units this month. Avoid planting in frosty soils and protect your bare root seedlings from freezing. Finish well before the moisture is gone from the soil.

✓ Complete fuel reduction projects around your structures and in your forest. Don't forget the outbuildings, public and private access roads, and that precommercial thinning project you just completed!

✓ Order seedlings for 2023 reforestation projects. Make sure your seedlings match your site.

✓ Install seedling protection measures before the tasty buds have opened.

✓ If you're pruning to improve aesthetics, and log value or to remove ladder fuels, finish before the sap begins to flow to minimize bark damage and insect activity.

✓ Survey nesting sites to record activity. Keep a sharp eye out for adults and sensitive young.

✓ Take some time to evaluate your riparian buffers and wetlands and how they enhance the local habitat and connectivity. How does your forestland contribute to the larger watershed and society?

APRIL

✓ Survey winter storm damage and plan for salvage and/or repair.

✓ Finish cutting firewood before fuels dry out to minimize the potential for wildfire. Spreading the cut wood on the ground will allow it to dry before collection.

✓ Plan for fire season: meet with neighbors, ask your fire protection agency for a courtesy inspection, prepare equipment, move firewood away from your house and assure adequate access for engines. Make sure your family members know what to do in the event of a fire. You are an important part of the fire prevention solution.

✓ Develop a recreation plan and get the family involved in clearing trails, camping areas, and fishing spots. Then take some time to just enjoy your property.

✓ Monitor your 2022 projects and update your photo points. Plan a tour for fellow forestland owners to share your accomplishments. You deserve a pat on the back from people who know!

FOR MORE INFORMATION...

check out these favorite websites and publications:

- www.natureswaybirds.com/blogs/news/spring-cleaning-is-for-the-birds
- uidaho.edu/extension/ipm (integrated pest management)
- fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5187526.pdf (pine engraver)
- catalog.extension.oregonstate.edu/em9184 (fuel reduction)
- knowyourforest.org/learning-library/logging-and-selling-timber
- timbertax.org
- catalog.extension.oregonstate.edu/ec1196 (Selecting and Buying Quality Tree Seedlings)
- mywaterway.epa.gov
- blogs.oregonstate.edu/treetopics/2021/02/16/storm-damage
- www.extension.uidaho.edu/publishing/pdf/CNR/PlantYourSeedlingsRight.pdf

Forest Health: In the Eye of the Beholder or a Standard Forest Measure?

By MICHELLE AGNE

Close your eyes and imagine a healthy forest. What do you see? Consider the size and structure of the trees, the species, the spacing, and the incidence of snags and downed wood. Although the term forest health is ubiquitous in forest management, chances are that every reader sees something slightly different when they imagine a healthy forest. The term forest health is everywhere—but what exactly does "healthy forest" mean when it can take different forms for different people?

Defining forest health

For many forest owners, forest health is defined by the amount of dead or low-vigor trees within a stand and the activity of forest pests that cause damage to trees. This includes insects, pathogens, and vertebrates. Does any number of dead trees or pest activity mean the forest is unhealthy? Not necessarily. Forest health is a condition tied to values for the forest, and therefore must be defined in the context of objectives and key services for the forest. In an even-aged plantation managed to generate income, a healthy forest is likely to have minimal mortality and no pests that cause tree deformities. On the other hand, in a late-successional stand managed to create wildlife habitat, a healthy forest might have openings, tree deformities, snags, and downed wood, all of which can contribute to complex forest structures for wildlife. But defining forest health in the context of your management objectives is just the first step, next is understanding which pests are present and how they are affecting your forest.

Not all pests are created equal

Forest pests have wildly varying characteristics and effects on forest health. Understanding key features of the pests you encounter is critical for anticipating how forest health will be affected. Here are four key questions to ask about a pest:

What is the effect on a single tree? Often, we think pests kill trees. This is true for many kinds of pests, such as bark beetles and root disease pathogens. However, some pests cause slow growth, dieback, or other structural deformities without necessarily causing mortality. Many defoliating insects and pathogens are included in this category, as well as dwarf mistletoes.

What is the effect on a whole forest stand? Understanding how pests damage individual trees is important. Knowing how this damage translates to the forest stand will provide a clear picture of the effects on forest health. Some pests can cause damage to every tree in a stand while others only target certain species based on size or weakness caused by a previous injury. For example, most bark beetles only attack a single species (or closely related species) over a certain size, leaving other species and smaller trees less susceptible to attack. Conversely, many root rot pathogens can infect a wider range of species, regardless of size. Heart rot pathogens generally affect low-vigor or injured trees while otherwise healthy trees are unlikely to be affected.

How does the pest spread through the forest? Depending on the pest, the spread can happen quickly (over the course of several years, such as with bark beetle outbreaks) or slowly (over decades, such as with root rot pathogens or dwarf mistletoes). Spreading can also happen through the air by live insects or spores transferring from one

affected tree to the next, or it can happen passively through the persistence of dead material on-site. Some pests can only survive in live trees so leaving dead material on-site will not make the problem worse. However, some pests build up in dead material such as slash piles, and attack live trees, potentially leading to a worse pest problem.

Is the pest native to the region or a non-native invasive species? Most forests have pests that coevolved with the tree species present and are therefore considered to be native. Tree species are typically adapted to some level of disturbance by native pests, and therefore native pests are unlikely to completely remove a species from the forest. One example of this is native bark beetles, such as the mountain pine beetle. Despite high levels of mortality, this native bark beetle does not remove species from a landscape, leaving small survivors and trees that have successfully defended against attacks. However, non-native invasive pests, those that have been recently introduced to the forest, are generally at odds with forest health. Native trees have little inherent ability to defend against invasive pests. In many cases, all susceptible trees are affected, with the potential to remove a species (or multiple species) from a whole stand or landscape. The presence of an invasive pest can lead to additional restrictions on the movement of timber outside of the affected area which causes a burden to forest owners. Examples of invasive pests affecting forests in the region are white pine blister rust, sudden oak death, and emerald ash borer, which was recently discovered in Oregon.

It is also important to note that pests can combine with other environmental stressors and disturbances to cause further damage to trees. Heatwaves or drought can weaken tree vigor, predisposing them to damage from some pests. Trees damaged by pests can be more susceptible to mortality from low-intensity fire, and trees damaged by low-intensity fire can attract some kinds of pests. Forests have less capacity to bounce back when multiple stressors combine and lead to an increased negative effect on overall health.

Managing pests and forest health

Unfortunately, there is no silver bullet when managing pests to achieve forest health. However, there are steps you can take to understand how pests are impacting the health of your forest and what to do about them.

Determine your management objectives. Management objectives vary widely but some examples might include creating wildlife habitat, generating income from timber harvest, providing recreation opportunities, and storing carbon. A forest with multiple objectives is common. Many landowners complete this step when developing a forest management plan. For more information on writing a forest management plan, see the Summer 2022 issue

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PHOTOS COURTESY: MICHELLE AGNE

Forests of the northwest with various pests. Left: Old growth coastal Douglas-fir forest with snags, possibly killed by heart rot. Top right: Subalpine mixed conifer forest with laminated root rot. Bottom right: Whitebark pine forest affected by white pine blister rust and mountain pine beetle.

"Management Plans Made Easier."

Identify pests and the impact they have on your forest. Pests vary with forest type, dominant species, and age class. As discussed above, they can have different effects on forests. Understanding whether pests are causing widespread forest mortality, or the gradual decline of individual trees is important for interpreting their effects on forest health. Identifying specific insect or pathogen pests can help to understand potential long-term effects on the forest. Insect and disease guides for your local area as well as Extension foresters are great resources for pest identification.

Evaluate forest health and conduct appropriate interventions. By understanding specific pest impacts on your forest, you can evaluate whether the pests are decreasing forest health concerning your management objectives. If mortality, decline, or damage to trees is substantial enough to detract from management objectives, taking action to control pests may be warranted. Effective pest control methods vary by species, so there is no one size fits all solution. Extension foresters and their guides are again an excellent resource if you are uncertain of appropriate control methods for the pest in your forest.

In general, many pests are species-specific in their attack. Planting a mix of species can provide insurance against the chance that any one species could be targeted by a pest. Eradication of native pests is not usually recommended as these agents are a part of the ecosystem with which the trees are coevolved but planting non-susceptible species can help to reduce pest problems in the future. On the other hand, invasive pests are often the target of coordinated programs to stop the spread of the pest to unaffected areas. If you suspect an invasive pest in your forest, contact local or state resources to understand what resources exist for containment or eradication. Prevention is the best tool against damage and economic losses caused by invasive pests. Avoid moving plant materials and firewood long distances and always clean boots and tools after visiting an area with an invasive pest.

Forest health—will you know it when you see it?

When it comes to forest health, there are few hard and fast rules. The presence of damaged or dead trees in a forest does not necessarily mean that the forest is unhealthy. Low levels of activity from certain pests can increase forest structural complexity by creating gaps and openings, wildlife trees, snags, and downed wood, which may be desirable for some landowners. However, high levels of forest pests can often result in poor forest health, especially when pests cause tree mortality, occur at very high levels, or are non-native invasive species. Such pests can remove species from a landscape or substantially change the function of a forest, which is at odds with many different management objectives. There is no single definition for forest health. Rather, it is a value that must be defined by each landowner in the context of their own goals for the forest. ■

Michelle Agne *is a postdoctoral fellow with the USDA Forest Service Pacific Northwest Research Station in Olympia, WA. Her research background is in forest disturbances, including fire, pathogens, and insect outbreaks, and understanding their effects on forest health and resilience. Currently, she is interested in developing strategies to assist landowners with climate-smart reforestation following disturbance. Michelle can be reached at Michelle.Agne@usda.gov.*

Monitoring Forest Health: The Eye in the Sky

By DANIEL DePINTE

There are approximately 86 million acres of forested land across Oregon, Washington, Idaho, and Montana. One may wonder, how in the world does the Forest Service monitor such a vast amount of forested terrain and diagnose all the different causes of forest damage each year? The USFS has been developing and evolving a system of monitoring and diagnosing forest health conditions for over 100 years.

The U.S. Forest Service's Forest Health Protection (FHP) program and its state partners collaborate annually to monitor the health of all forested lands across Oregon, Washington, Idaho, and Montana. If significant forest damage occurs, especially from insect and disease activity, FHP is typically one of the groups to know. Forest Health Protection then shares its observations of forest damage with the appropriate land managers for any given area. Collectively, FHP works with all federal, state, and private landowners to assist with their forest health concerns.

It all starts with forest health specialists who are typically trained in the fields of forest entomology and forest pathology. Over time, these specialists have observed and recorded insect and disease patterns affecting different tree species. They closely monitor how the infected trees succumb to their demise and note the subtle differences, or signatures, between the different insects and how the tree reacts. Specialists can differentiate what is happening across the forested landscape. This knowledge has been passed down for generations, through training and demonstration, creating an extremely solid foundation upon which we can build.

As the science of monitoring continues to develop and new technologies emerge, FHP evaluates them for usefulness and when appropriate, adopts new tools to increase the quality of the data, the safety of the crew, and the efficacy of the survey and monitoring program. Currently, we use a hybrid approach to surveying and monitoring which uses a mix of operational remote sensing tools including Unmanned Aviation Systems (UAS), staffed aircraft, and satellite imagery.

PHOTO COURTESY: VISION AERIAL

American-made tri-copter SwitchBlade-Elite from Vision Aerial.

Forest Health Protection understands the potential of flying UAS ("drones") to support a host of natural resource management activities regarding forest health concerns. The Forest Service takes a deliberate approach to all new technologies, such as UAS, to ensure they are adopted in an appropriate, safe, and cost-effective manner. They want to ensure the right asset is utilized to support the agency in accomplishing its mission while staying aligned with FAA regulations.

The Forest Service has a fleet of drones that can be equipped with various sensors tailored to a diversity of forest health survey missions. For example, if we need to diagnose the cause of a defoliation event in a mixed conifer forest up on a mountainside, we could use our DJI Mavic Pro with its high-definition camera sensors to see more clearly what is happening in the canopy. Other forest health missions may need more specialized sensors like the Micasense RedEdge-P which can go beyond what the human eye can see into the non-visible light spectrum. For these types of missions, we use the American-made tri-copter Switch Blade from Vision Aerial which can be mounted with a variety of mid-weight sensors. We also have larger drones such as the DJI Matrice M600 Pro which can be furnished with heavier equipment such as the GeoCue True View 515 LiDAR sensor. The main advantage of LiDAR sensors coupled with data interpretation tools is the ability to capture tree and shrub cover information and then remove it to obtain ground elevations even in dense forest canopies and the ability to accurately create canopy height models. Currently, UAS missions are only suitable for relatively small project sites of no more than a couple thousand acres. Beyond that, staffed aerial surveys are more appropriate.

Staffed aerial surveys provide an annual snapshot of forest health conditions over large areas and most of the annual monitoring is accomplished using this technique. Aerial surveys are more efficient, reliable, timely, and economical than other operational remote sensing methods to date. In the US, forest health surveys started in the 1920s and have been consistently con-

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ducted in the Pacific Northwest since 1947. Each year, since those early days, the aerial detection survey improves upon the last by modifying aircraft, passing along knowledge, and developing customized tools to assist in the monitoring of America's forests.

To conduct the aerial detection survey (ADS), forest health specialists board small aircraft armed with a digital aerial sketch-mapping system that incorporates tablets, geographic information system (GIS), and global positioning system (GPS) technology into a single app called Digital Mobile Sketch Mapper (DMSM). The forest health crew then flies over the forests anywhere from 500 to 2000 feet above the canopy in either a grid or contour pattern depending on the terrain below. Traveling around 100 mph the surveyors looking out about two miles can survey around 15-30 acres per second, diagnosing forest damage, mapping its extent, and rating the severity of that damage for any given location for less than a penny per acre. In real-time, forest health specialists can distinguish between the different tree species and the variety of damage causal agents which could be impacting each tree species.

For example, let's imagine a large ponderosa pine forest. As we fly over this forest, specialists are looking out the windows for different forest characteristics such as the color and quality of the canopy to determine if the trees are healthy, defoliated, dying, or recently dead. As a ponderosa pine dies, typically the foliage will transition from a green to a specific chlorotic yellow-straw color, then to an orange-reddish color. The arrangement of the dying or recently dead ponderosa pines can further tell us more about the possible cause of this forest damage. If the pines are all the same color of red and recently dead along one side of a highway and those dead trees only extend about 100 yards from the highway while the rest of the forest is healthy and green, then salt or herbicide damage from road management are most likely the cause. Now imagine that we fly further and observe clusters of dead ponderosa pines in a variety of fading canopy colors scattered throughout the forest. Bark beetles are most likely the cause of such patchy mortality. The same goes for defoliation events in ponderosa pines and, based on the topographic position of the trees and which needles (interior older foliage only, exterior youngest foliage only, top-down, bottom-up) specialists can make an educated guess from the plane whether it is most likely pandora moths, pine butterflies, sawflies, foliage pathogens, or fire damaging those ponderosa pine needles. This process of distinguishing the subtle differences repeats for each tree species and location as we fly along recording our observations on the DMSM app which keeps track of the plane's location on a customizable scrolling map. Using a variety of imagery as a background for this map, surveyors can easily correlate the damage they are observing out the window and locate where the damage would be on the app's map.

PHOTO COURTESY: DANIEL DePINTE

To conduct an aerial survey, forest health specialists use small aircraft armed with a digital aerial sketch-mapping system.

The aerial survey data is collected over the summer and into the fall to capture the best forest damage signatures possible, then processed in the fall and finished by November 15th. The raw or 'draft' aerial detection survey data, which is not processed, is shared publicly online on our website, typically the same week that area is flown. During the survey season, we periodically check areas of damage on the ground for verification, especially prioritizing "unknown" damage that's been observed and following up to review areas of high value such as timber management project areas, campgrounds, or areas that may have damage from a new invasive insect or pathogen such as emerald ash borer or sudden oak death. No algorithm,

artificial intelligence, or sensor to date has been able to replace the ability of an educated forest health specialist to diagnose and map hundreds of millions of forested acres and share those findings at the speed and cost that is currently happening with aerial surveys. But that won't always be the case.

Using imagery from satellites has shown some promising results for the future of monitoring forest health across large landscapes and is currently being used in conjunction with aerial surveys from aircraft, when applicable, to increase the quality or the extent of the data produced by FHP and their State Partners. The USFS has access to the MAXAR satellite fleet from the National Geospatial-Intelligence Agency which provides high-resolution imagery. This imagery can then be analyzed in a variety of ways to map damage or detect changes across the landscape over time. In 2021, when the heat dome event slowly crossed Washington and Oregon, brutally scorching trees across hundreds of thousands of acres, FHP used imagery from Worldview-3 in conjunction with aerial survey data to map the extent and severity of the foliar damage. This mapping was accomplished with what is called heads-up digitizing, where a human draws the lines around the visible damage on the provided imagery. Other remote sensing techniques develop algorithms that detect the change by comparing satellite images of the current forest to how that forest looked in the past.

In the Pacific Northwest, FHP, Washington Department of Natural Resources (WADNR), and Oregon State University's College of Earth, Ocean, and Atmospheric Sciences are collaborating to develop and fine-tune those algorithms and digital tools, such as LandTrendr, to assist with forest health change detection. We also collaborate with other federal and private groups such as the Geospatial Technology and Applications Center (GTAC) and Redcastle Resources, which share the same goal of change detection and forest health monitoring but take different approaches. Each approach may use a different set of satellite imagery with varying resolution or focus on a different component of the landscape such as a change in greenness or infrared spectrum imagery. Collectively we are moving forward with new technology and providing the best available monitoring possible.

As the forests change over time, so will the tools we use to detect and monitor those changes. The importance of monitoring forest health has always been vital. With the impacts of climate change being felt across the landscape now, more than ever, we need to remain vigilant in our monitoring of forest health. The interconnected nature of climate, insects, diseases, wildfires, and forests is complex, and scientists will continue to better understand those relationships. With that understanding, hopefully, we can mitigate some of the damage and plan for future forests with greater success. For more information on forest health, or to see the current state of the aerial detection survey in Oregon and Washington, please visit our website at https://www.fs.usda.gov/main/r6/forest-grasslandhealth. ■

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Is a Key Species for Building Healthy Forests Getting Sick?

By ERIKA EIDSON

Top kill in young larch caused by wood-boring moths

Western larch is one of the most prized tree species in the region. It produces valuable timber, is resistant to fire, has a beautiful fall color, and is often recommended for planting by forest health professionals due to its limited problems with major insects and diseases.

Perhaps most importantly, planting western larch (along with western white pine) is often touted as the 'cure' for root disease. Although root disease can never truly be cured, western larch is one of the least susceptible tree species to *Armillaria* root disease, which is the most widespread root disease in the inland northwest. As such, larch is an important species for forest health restoration and over 100,000 western larch seedlings are planted each year in north Idaho by state and federal agencies.

Recently, forest landowners and managers have been surprised to see healthy young larch trees exhibiting strange new damage. Tops were yellowing, then dying. In some cases, whole trees were killed. Right around the lower margin of the top kill, there were oozing trunk 'blemishes' where the bark was flattened and cracked. These symptoms have not been documented in larch before. Although the problem is not currently widespread, it is cause for concern.

When did we start seeing problems?

The Idaho Department of Lands (IDL) Forest Health team covers insect and disease issues across the state. The first suspected documentation of this problem in Idaho, ironically, occurred in the backyard of Tom Eckberg, IDL's Forest Health Program Manager.

In 2014, Tom noticed his backyard larch tree had a trunk blemish, along with some red, sawdust-like material on the bark. A trained entomologist, he recognized the 'sawdust' as frass or insect poop. Tom looked under layers of bark to find out who was invading his tree. He extracted a small caterpillar that looked like it belonged in the *Tortricidae* family, a very large family of usually small and drab moths.

Having never seen anything like this on larch before, he thought it was a fluke. Fortunately for Tom's tree, his curiosity and quick action saved its life. To this day, it sports a healing scar, but it is doing well and shows no other signs of damage.

Four years later, in 2018, Tom received the first report of top kill, mortality, and trunk blemishes in otherwise healthy-looking western larch near Orofino, Idaho. Forest health professionals also received reports of similar damage in Spirit Lake, Coeur d'Alene, and eastern Washington. Peeling back the bark again revealed Tortricid-looking caterpillars in the affected trees.

What's the damage?

So far, top kill and mortality have only been reported on western larch trees. The first noticeable symptom is yellowing from the top down. In most reports, top kill progresses down the trunk over several years, sometimes killing the entire tree. Attacks usually occur on young trees less than about 15 feet in height. Attacks have been reported on trees as small as 1.3 inches in diameter and as large as about 14 inches in diameter.

Affected stands are usually no more than about 30 years old. Damage typically occurs scattered throughout the stand or in small patches, and western larch mortality has been recorded in both pure and mixed species stands.

Attack sites can often be found less than 10 feet up the trunk and are usually located near small limbs. Typical trunk blemishes present with sunken, cracked bark exuding resin of varying viscosity. Thinner resin can give the blemishes a 'bleeding' appearance, whereas thicker, drying resin looks gummy. If the attack is recent, reddish frass may be visible from insect feeding, but rain will wash it away.

Excavating the trunk blemishes reveals a depression in the wood where feeding occurred, some callusing of

the wound, and more dried and drying resin pockets. There is often a copious amount of sap around a single caterpillar, or larva. Webbing beneath the bark has also been documented, but it is unknown whether it was incidental or associated with the insect. There appears to be repeated feeding by multiple generations in the same general location under the bark.

Who is the culprit?

The caterpillars extracted from the trunk blemishes were sent to the USDA Animal and Plant Health Inspection Service and identified using DNA analysis based on comparative entries in the Barcode of Life Database (BOLD). The closest match in BOLD was a species of moth in the Tortricidae family called *Cydia rana*, which occurs in the eastern United States.

A closely related western species, *Cydia laricana*, was first documented in Montana over 100 years ago. However, no specimens of *Cydia laricana* were listed in BOLD for comparison. Due to field observations of feeding on western larch, as well as uncertainty regarding whether multiple related species are involved, the caterpillars have thus been deemed *Cydia laricana* complex.

Cydia laricana, formerly called *Laspeyresia laricana*, is a small, drab, wood-boring moth with a wingspan of about 14-17 mm. It was first documented infesting Douglas-fir in Montana in 1913, and then in western larch in Montana in 1914 (Heinrich, 1926). There was no mention of it causing tree mortality, and it has not been documented as killing trees until recently.

At this time, information regarding the complex biology of *Cydia laricana* is speculative and more monitoring is needed to understand its life cycle. Generally, wood-boring moths lay their eggs on the bark of host trees, the eggs hatch, and larvae chew their way into the tree. It appears that *Cydia laricana* complex larvae tunnel into the wood of host trees to feed, develop, and pupate. Following pupation, adult moths emerge, mate, and lay eggs, thus completing a generation. Similar moths usually have a one or two-year life cycle per generation. Adult moths of *Cydia laricana* have been collected in Montana in May, suggesting that subsequent attacks on new trees may occur in spring.

Ongoing research

In 2020, the University of Idaho, the Idaho Department of Lands, and the USDA Forest Service launched a research project to learn more about this insect. The primary goal was to capture adults to confirm the *Cydia laricana* complex identification, learn more about its life cycle, and assess different trapping methods for future research.

Four different methods for capturing adult *Cydia laricana* complex moths were tested, including:

Pheromone traps

Sticky cardboard traps baited with female moth sex pheromones can be used to capture male moths. The male moths, enter the trap and become stuck in the coating on the inside. Due to its obscurity, pheromone lures have not been developed for *Cydia laricana* specifically. However, pheromone lures are available for the codling moth (*Cydia pomonella*), a related species that is a major pest in orchards. Codling moth pheromones were used in the traps for this research because they were the closest available alternative.

U.V. light traps

Black light traps are effective devices for capturing many species of night-flying moths. The low-wavelength light lures in a diversity of flying insects from the surrounding area, and captured specimens are typically more intact and easier to work with than those captured in sticky traps. U.V. light traps were constructed following guidelines developed by White *et al*., 2016.

In situ cages on attacked trees

Trees were identified in the field showing symptoms of *Cydia laricana* complex attack. Trees were left intact, and screen cages were placed around the trunks of the trees such that insects that emerge from the caged area of the trunk would be trapped.

Cut trees placed in "rearing cages"

Symptomatic trees were also cut down and brought back to research labs in Coeur d'Alene and Moscow for monitoring. The cut logs were fully enclosed in cages and monitored regularly to identify any emerging moths.

Ultimately, the codling moth pheromone traps and the rearing cages proved to be the best options

—Continued on next page—

for capturing adult *Cydia laricana* complex moths. Further DNA analysis of collected specimens confirmed the identification of *Cydia laricana* complex at three sites in northern Idaho and northeastern Washington in 2021 and 2022.

Moths that emerged from the logs in the rearing cages did so in May and early June, supporting the hypothesis that the attack period for this insect is in late spring. Very recently, relatively large caterpillar specimens (presumably more mature larvae) have been found actively feeding in western larch in September and October, which may also support this hypothesis.

Ongoing and future research on the *Cydia laricana* complex will focus on affected stand characteristics such as stocking density, slope, aspect, soil chemistry, and host tree seed source, as well as developing more information on overall biology and life history.

What can we do?

It is important to remember that research takes time. Although studies are underway, it will likely take years before forest health professionals can develop specific management recommendations for this presumably native insect. Until there is more information available on its life cycle, population drivers, and host tree susceptibility, management recommendations are purely speculative based on similar wood-boring moths.

PHOTO COURTESY: ISABELLA VALDEZ, IDAHO DEPARTMENT OF LANDS

Larch topkill due to* Cydia laricana *complex, September, 2022.

In landscaped settings, the most effective treatment to protect trees from wood-boring moths is typically an insecticide. High concentrations of permethrin or other chemicals that are appropriately labeled for treatment would be sprayed on the bark during the attack period (egg laying through egg hatch). However, due to the lack of information on the complex lifecycle of *Cydia laricana*, appropriate application timing has not been confirmed. Notably, imidacloprid, a popular soil drench systemic insecticide, is generally not an effective treatment against the larvae of most wood-boring moths.

In forest settings, bark-spray insecticides are often impractical and not labeled for widespread use. It is always important to read and follow the label when applying any pesticide. Promptly removing and destroying (chipping or

PHOTO COURTESY: GINA DAVIS, U.S. FOREST SERVICE

Cydia laricana *complex attack site with caterpillar.*

PHOTO COURTESY: GINA DAVIS, U.S. FOREST SERVICE

Excavated attack site showing* Cydia laricana *complex larva surrounded by frass and resin.

burning) infested trees when symptoms first appear may help reduce populations of *Cydia laricana* complex within a stand, but population dynamics of this insect are not well understood.

Some evidence suggests that thinning may not be an effective means for increasing stand resistance to *Cydia laricana* complex. Several reports originated from young stands that had recently been thinned, but this is still being investigated. So far, the species composition of a stand does not appear to be a major factor for tree susceptibility, as the damage has been reported in stands even where larch is only a minor component.

Western larch has a very narrow seed transfer zone and is sensitive to drought. Planting larch from inappropriate seed sources, or on sites that are too dry, can increase stress. Stressed trees have compromised defense systems. Planting 'the right tree in the right place' may help to reduce stress and thereby improve resistance to the *Cydia laricana* complex.

The bottom line

Western larch is a valuable and important tree species, so any threat is concerning. We still have much to learn about the *Cydia laricana* complex. Why is it contributing to larch mortality now, when it hasn't been known to cause problems in the past? Why are some larch trees attacked but not others? Is it acting alone, or in concert with other insects, diseases, or climate conditions? This fall, up to three morphologically distinct caterpillars have been pulled from the same larch tree, suggesting multiple species may be at work. *Cydia laricana* complex has also been documented in larch trees alongside the native larch engraver beetle (*Scolytus laricis*) and in trees affected by foliar issues such as needle cast, needle blight, and larch casebearer.

As more information becomes available, management recommendations can be developed. Fortunately, only small, and sporadic areas of larch have been affected and western larch is still recommended for planting. ■

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What Scientists Know About Free-Roaming Pet Dogs and Cats

By ED STYSKEL

This treatise is about the quandary of owning or sheltering domestic dogs and cats as pets within the domain of your household or empire. The dilemma is that human benefits from pet companionship and services also come with adverse environmental impacts that we may not see, understand, or even care about. The brief findings herein are from my extensive review of 155 relevant scientific studies in the USA and around the world.

Let me start by clarifying that domestic dogs (*Canis familiaris*) and cats (*Felis catus*) are not native to North America. They were introduced by nomadic travelers and were bred and domesticated for human companionship or to serve as animal guardians, guides, herders, or hunters. They could be considered exotic pests for the harm that I will describe below. Adverse impacts arise when pets are allowed or escape to roam freely from their human home.

Roaming Behavior

Research data shows that domestic cats and dogs can roam long distances beyond their owner's control. Most USA studies report cats roaming an average of approximately 100 feet from home. Home territory size is commonly 1 to 8 acres per owned cat. There are only a few USA studies of dog roaming behavior while absent of their owner. One owned dog is known to range 1.1 miles, but three of four owned dogs roamed no farther than about 1,600 feet from a human structure. Dogs that accompany their owner on outdoor excursions usually stay closer than when roaming solo. No data was found for owned dog home territory size in the USA, but other countries report a range of 2 to 254 acres.

Pets Chase, Injure, and Kill Wildlife

Many wildlife disturbance studies conclude that dogs-with-people, dogs-on-leash, or loose dogs provoked the most pronounced disturbance reactions from their study animals. Dog barking and scent-marking extend the disturbance zone toward wildlife, and free-roaming dogs flush, chase, injure, and kill wildlife. Those disturbances

PHOTO COURTESY: RIHAU FROM PIXABAY

The domestic cat has been described by many scientists as the most harmful anthropologic threat to songbird populations in North America.

attract native predators, restrict feeding or breeding activity, and divert parents from rearing their young. Imagine the stress of our existence if we lived unprotected at ground level and outdoors amidst native predators, and then unexpectedly encountered an African lion or Alaskan brown bear.

Free-roaming cats are stealthy, instinctive predators that commonly injure or kill their wildlife prey. In the USA, cats that roam free or feral are estimated to kill 1.3 to 4 billion birds and 6.3 to 22.3 billion mammals each year. Studies in the eastern USA estimate that each rural outdoor pet cat kills 23–42 birds a year on average. My county in northeastern Washington hosts at least 235 bird species. Of those 235 species, 182 breed here, and 66 make their nests on the ground. Other ground-level inhabitants are 73 mammals, 8 reptiles, and 6 amphibians. Wildlife that nests, forage, or shelter on the ground are vulnerable to free-roaming domestic dogs and cats.

Evidence of wildlife mortality from pet dogs and cats is routinely hidden from discovery in rural or densely vegetated locations. However, one study in north Idaho did document 39 incidents of dogs chasing deer on winter range. Those chases directly resulted in the death of 9 white-tailed deer and 3 mule deer. Of the 27 deer that escaped, 2 were crippled but fled from sight, and 2 ran unhurt into a river for escape.

Hosts and Victims of Disease

Domestic dogs can be the victim and source of infection for native wildlife populations. For those reasons, their

presence in a rural natural environment can start and spread infections to a large variety of wildlife species.

Dog pathogens that represent a serious threat to wildlife conservation include canine distemper virus (CDV), canine *Parvovirus* (CPV), canine *Coronavirus* (CCV), canine *Adenovirus* (CAV), canine *Herpesvirus* (CHV), *Lyssavirus*, *Neosporacaninum*, *Toxoplasma* spp., *Leishmania* spp., *Leptospira* spp., and *Salmonell*a spp.

The Oregon Department of Environmental Quality identified pet waste as a significant contributor to *E. coli* bacteria, one of the region's most ubiquitous and serious pollutants. Contact with *E. coli*-polluted water can make humans sick. The average dog produces 1/2 to 3/4 pounds of fecal matter each day, and the feces can pollute water. Tualatin River Basin stream studies discovered that dog waste alone accounted for an average of 13% of the fecal bacteria therein.

The status of domestic cats has changed from mere animals to barn mousers, to human companions. Most people today do not think of cats as transmitters of infectious agents from animals to humans to other cats, so it may be astonishing to learn that cats carry 273 infectious agents of which 151 (55%) are shared by humans. Of those, toxoplasmosis is one of the most serious.

A 2014 survey in the United States reported that 11 percent of the human population has toxoplasmosis antibodies indicating past infection. *Toxoplasmosis gondii*, the protozoa causing the disease, begins its life cycle when a cat—usually a kitten—becomes infected and is often asymptomatic. It excretes feces containing up to 50 million infective oocysts (protozoan spores) per day for an average of 8 days. At any given time, approximately one in 100 cats is infectious and excreting oocysts.

Oocysts can survive up to 18 months in the loose soil of gardens, sandboxes, animal barns, and other places; in freshwater, they can survive for up to 54 months. When oocysts dry, they may aerosolize, float in the air, and are capable of being inhaled. Infections occur from contact with cat litter, or by eating improperly washed fruit or vegetables and undercooked meat. Adults and children in homes without cats can become infected by cats in the neighborhood. The presence of just one infected cat can contaminate a natural area with *T. gondii* oocysts, thereby increasing the risk of exposure to wildlife.

Water becomes contaminated when cat feces on the ground are carried by rainwater into streams, or when cat litter is dumped on the ground or flushed down the toilet. Such a drinking water outbreak occurred in Vancouver, BC in 1995.

The great majority of toxoplasmosis infections in humans produce very minor or no symptoms, so most people are unaware of the infection unless doctors specifically test for it. Three exceptions produce serious effects. One is when the parasite gets into the brain as cerebral toxoplasmosis and there is no effective medical treatment. People who are immuno-suppressed from a serious disease, cancer treatment, or organ transplant may be more vulnerable to *T. gondii*. The parasite is significantly associated with personality disorders

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An Introduction to Root Disease Management in the Pacific Northwest

By ALICIA CHRISTIANSEN

When a storm comes through your forest, the damage is obvious. You'll see broken limbs and tops and windthrown trees. Based on these physical, visible signs, you will know exactly where to target your clean-up and harvest activities. But when insects and disease enter a forest, the damage isn't always as obvious as that of a storm. The signs and symptoms can be inconspicuous at first, and by the time damage is visible, it might be too late to combat the issue. This can be especially challenging for landowners dealing with root diseases.

Root diseases affect all conifer species in the Pacific Northwest and are broadly recognized by professional foresters as being the most serious and difficult forest disease to identify, quantify, and manage. Root diseases are caused by fungi that harm trees by decaying and killing tree root systems (except for black stain root disease, which plugs water-conducting tissues leading to mortality). Trees affected by root diseases are often more susceptible to attacks by bark beetles and wood-boring insects.

Root diseases are responsible for substantial losses of timber; up to 18% of conifer volume mortality in the West is believed to be associated with root diseases. A lot of research has been done to understand root disease recognition, how they spread and damage host trees, and how to manage forests plagued by them. While root diseases can be caused by abiotic agents (such as drought, flooding, or soil compaction), the most damaging root diseases of conifers in PNW forest settings are caused by fungi.

Table 1.

Root disease and cause	Major hosts	Key identifiers	Distribution
Laminated root rot *Phellinus sulphurascens* (*P. weirii* is the former name)	Douglas-fir, true firs, mountain hemlock	▪ Laminated decay ▪ Ectotrophic mycelia ▪ Setal hyphae	Throughout host range, especially west of Cascades, but uncommon in eastern Oregon; occurs in the area south of the Crooked River and east of Hwy. 97
Armillaria root disease *Armillaria ostoyae*	Douglas-fir, true firs, hemlock, pine, spruce	▪ Mycelial fans ▪ Rhizomorphs ▪ Yellow-stringy decay	Throughout host range; susceptibility varies with locale
Heterobasidion root disease *Heterobasidion occidentale* on fir, spruce, and hemlock *H. irregulare* on pines (*H. annosum* is the former name)	True firs, pine, hemlock, spruce	▪ Hidden conks ▪ Ectotrophic mycelia ▪ Laminated or stringy decay	Throughout host range, especially east of Cascades and in southwest Oregon Mostly a butt rot of hemlock and spruce along the coast; tree killer and butt rot of true firs in the dry forests May be locally important in pine
Black stain root disease *Leptographium wageneri*	Douglas-fir, ponderosa pine	▪ Black stain in wood limited to one to three growth rings, but no decay	Douglas-fir west of the Cascades; ponderosa pine east of the Cascades
Port-Orford-cedar root disease *Phytophthora lateralis*	Port-Orford-cedar	▪ Brown stain in inner bark, but no decay	Throughout host range in southwest Oregon

The majority of root disease damage in Oregon and Washington is caused by five root diseases: laminated root rot, Armillaria root disease, annosus root disease, black stain root disease, and Port-Orford-cedar root disease (Table 1). A few less common, but locally important, root diseases that cause minor losses at a regional level are Schweinitzii root rot, tomentosus root rot, and yellow root rot.

Proper identification and early detection of root disease pockets are key to the successful treatment and management of affected areas. Different root diseases will present a specific combination of symptoms unique to that disease, and depending on the host and causal fungi, treatment will vary as well. It can be difficult to learn how to

recognize root diseases, as symptoms are not always present in tree crowns and may only be found by digging to expose roots for examination. Even so, as woodland owners, it's important to learn how to recognize root-disease-affected trees to avoid misidentifying the causal agent and reduce potential losses in your forest (mortality is often blamed on insects because root disease fungi are difficult to see/access).

Trees affected by root disease will generally go through a similar progression of symptoms. First, growth height is reduced as demonstrated by the rounding of the tops, followed by needle loss which makes the crowns appear thin. Then foliage turns yellow, branches begin to die, trees produce a distressed crop of smaller than normal cones, and last, the tree dies.

While single trees can be affected by root diseases, you will normally see root disease pockets where symptomatic infected trees are all clumped together. Often these patches also called disease centers, create gaps in the canopy indicated by groups of the dead, dying, and often windthrown trees (Figure 1). An important thing to keep in mind is that the visible above-ground symptoms only represent about half of the total area that is affected by root disease.

Root diseases spread through a forest slowly and persist on tree roots long-term—anywhere from 1 or 2 years to hundreds of years. They depend on

PHOTO COURTESY: ROBERT L. JAMES

Figure 1.

connectivity between adjacent tree roots to transfer from tree root to tree root. The progression of the disease through a forest, and the persistence of the fungi, depend on several factors, including tree species, stand density, and fungus species. If you're trying to determine if trees are impacted by root disease, you can generally assume so if there is a spectrum of physical above-ground symptoms on neighboring trees, including sparse foliage, reduced height growth each year, snags that have been dead for many years, windthrow, and infestation of other disease-causing organisms and insects. This combination of factors results in a progression of stressed and dead trees in a concentrated area.

Tree species vary in how susceptible they are to root disease infection. For example, hardwoods are not affected by Port-Orford-cedar root disease, black stain root disease, or laminated root rot. While Heterobasidion (previously known as annosus) and Armillaria root diseases can affect both conifers and hardwoods, it is uncommon for cross-over to occur, therefore hardwoods are often recommended to plant or favor in many root-disease-affected areas.

If you suspect that you have an area that may be affected by root disease, it is important to start by surveying to map the disease in the stand. If you recently completed a timber harvest, this is easy to do by just walking through and looking for stains or decay on stump tops. Over time, stains can fade, so mark the infected trees with parallel

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Insect Outbreaks After a Fire, What's the Risk?

By PETER KOLB

Wildfires are complex events that vary by the landscape, weather, fuels, and tree species they burn. The same can be stated regarding insect and disease pests that infest trees. Combine the two and the potential after-effects get even more difficult to project. Years of post-fire monitoring in a variety of studies have provided some general trends that are worth considering.

Wildfires that develop into crown fires, combust tree foliage and "cook" the tree cambium, rarely leave trees that are suitable for common tree-killing beetles or defoliators to feed on. The carbohydrate-rich inner bark is heated to the point where it provides poor food and habitat for bark beetle broods to complete their life cycle. Fire-killed cambium is either dried out or quickly "sours" due to the action of yeasts, bacteria, and fungi that start feeding on the sugar and starch of the baked inner bark and cambium. If enough bark is left on the trees, flathead, and roundhead borers (Buprestidae and Cerambycidea) can make a living as their larvae can feed on the compromised cambium tissue and sapwood. These wood-boring insects rarely attack and kill live trees unless trees are severely compromised by some injury or other agent. They also function as important vectors for wood decomposition and as a major food source for bark gleaning and woodpecker species that find food and nesting sources from fire-killed forests.

Insect colonization of fire-killed trees will vary by tree species that in a post-fire assessment can be separated into **thin-bark** trees and **thick-bark** trees. Lodgepole pine, spruce, true fir, and cedar species have relatively thin bark that is easily damaged by heat and often "pops" or peels off trees as the heat of fire turns the sap into steam.

Their thicker foliage and pitchy inner bark also tend to promote crown fires and severe wildfire effects, thus "hot" fires. As a result, they provide poor pot-fire habitats for insects, fungi, yeast, or bacteria that can feed on the sugar-rich inner bark. It is also why these tree species will often remain standing for a decade or more after a fire as the exposed wood quickly dries out and does not support decaying organisms except at the tree base where soil keeps the wood moist. Additionally, when killed by a severe fire, they are poor habitat for cavity-nesting birds.

Thick-barked tree species such as ponderosa pine, Douglas-fir, and western larch are better survivors of fire because thick bark protects the cambium. This heat resistance mechanism also provides bark beetles with better habitat, even when the trees are killed by crown fires or injured by surface fires where soil surface fuel loading is high. On steep slopes, the uphill side of stems is often injured as heat reflects off the slope back onto the stem. This is commonly where fire scars are found on trees which are used to determine the fire history of a site. Stand-replacing fires that outright kill most trees do not promote population surges of tree-killing insects such as bark beetles, although mixed-severity and understory fires can. Trees that are partially scorched or have stem damage from a fire but retain live tissue can be more susceptible to attacks and colonization by beetles. The severity of damage varies by tree species and their pre-fire condition. Ponderosa pine responds to heat injury by routing copious amounts of pitch to injured areas, which may act as an insect deterrent. Pitch production is partially determined by how

—Continued on next page—

PHOTOS COURTESY: PETER KOLB

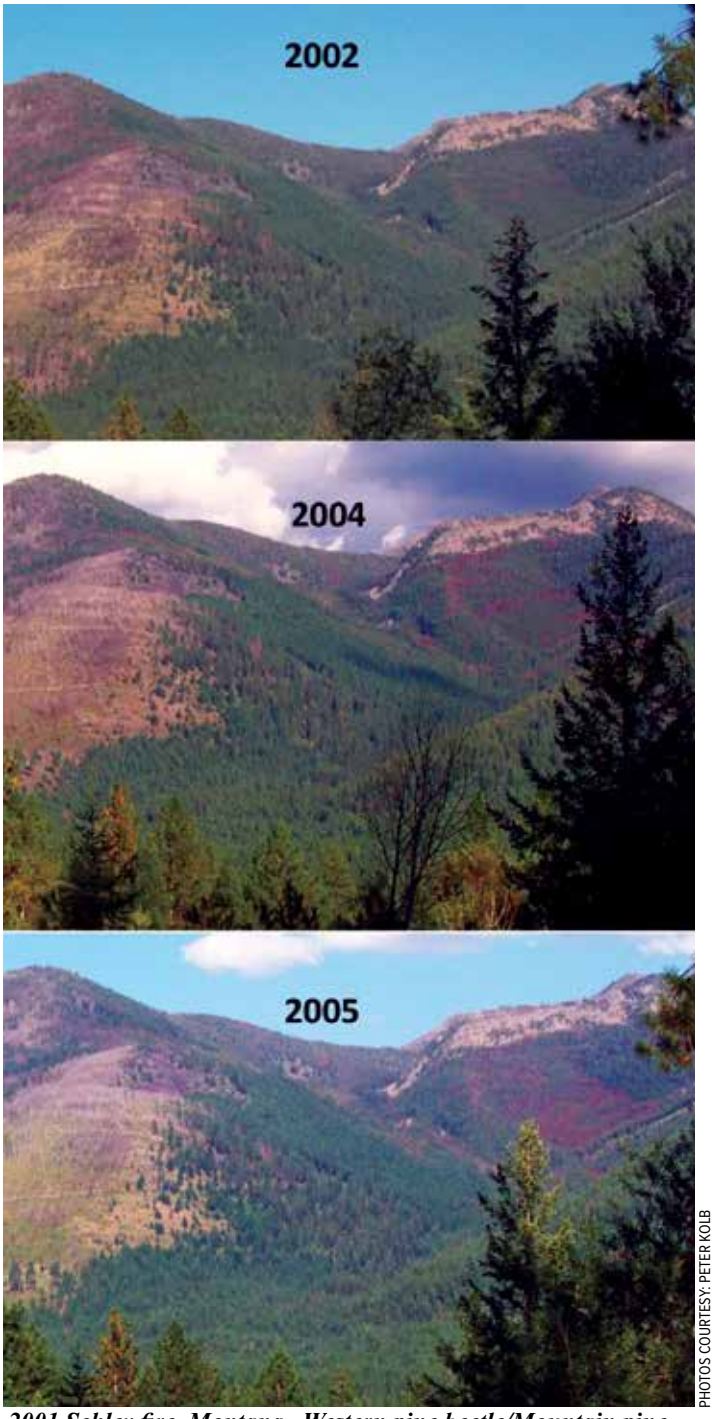
Lodgepole pine with some Douglas-fir 10 years after a fire. The thin bark of lodgepole pine (top) does not cling to trees after fire whereas the thick bark of Douglas-fir (bottom) does create ideal habitat for insects and woodpeckers.

much excess carbohydrates the tree has and water availability. Healthy ponderosa pines may be able to pitch out any insects attracted to fire-damaged trees, whereas stressed ponderosa pine that cannot saturate injured areas with mass pitch flows may be easily colonized. Red turpentine beetles, and flathead and roundhead borers, which typically are not tree-killing agents, are documented to be strongly associated with post-fire ponderosa pine mortality. Western pine beetle can also propagate in fire-damaged trees, though mountain pine beetle and pine engravers only propagate on specific sites, but less commonly.

The most significant beetle-caused mortality associated with wildfire is the Douglas-fir beetle in mature stands of Douglas-fir injured by fire. For example, the Montana "Valley Complex" fire of 2000 (about 360,000 acres impacted) in the southern Bitterroot valley allowed a minor infestation of Douglas-fir beetle on about 50 acres to expand to over 50,000 acres within 5 years. Mature Douglas-fir and some western larches were impacted, though larch appears to be a poor host for propagating beetle outbreaks. Similar Douglas-fir beetle outbreaks have been noted in a variety of wildfire-affected forests across the NW over the past 50+ years.

Tree mortality after a wildfire and its correlation with insect pest outbreaks can be quite variable and depends on multiple factors that may include: 1) stand condition before the fire (overall growth rates, presence of root diseases, soils); 2) area and density of susceptible mature fire injured trees and degree of fire injury; 3) presence of different insect pests, and 4) post-fire weather (precipitation). Tree mortality after a fire can also be a rather lengthy process. With time, Ponderosa pine and western larch appear to be the best survivors with the capability of healing fire injuries. Younger trees survive as much as 75% of stem circumference damage, and

2000 Valley Complex fire Montana. Post-fire Douglas-fir beetle outbreak.



PHOTOS COURTESY: PETER KOLB

2001 Schley fire, Montana. Western pine beetle/Mountain pine beetle complex development in adjacent stands over time.

Table 1. Mixed ponderosa pine and Douglas-fir survival rates.

Fire damage description	1-year	3-years	20 -years
Surviving mature trees some visible fire stem damage	261	157	28*
Surviving mature trees no visible fire stem damage	128	97	64*

Mature tree fire recovery study: Valley complex fire 2000 Montana (PKolb unpublished data). *only ponderosa pine survived

older trees survive as much as 50%. The amount of crown scorch also factors into the ability to survive but this varies tremendously. Western larch has been observed to recover with only 5% viable crowns remaining and ponderosa pine with 10% of the crown remaining. Douglas-fir, although thought of as a moderately fire-resistant tree species, is much more sensitive to long-term survival after wildfire damage. A 20-year study that tracked surviving trees in the Valley Complex fires (southern Bitterroot Montana) showed that most fire-damaged Douglas-fir that survived one to three years after the fire perished within the next 17 years from multiple factors including Douglas-fir beetle (Table 1). This species (inland variety) tends to have a shallow root crown that incurs significant damage from duff consumption. This eventually leads to loss of live xylem and restricted water flow, which predisposes the trees to a slow death. Fire-injured Douglas-fir, though likely doomed to die from fire injuries, lives long enough to produce mass cone crops that result in mass seedling recruitment in the years following a fire. Thus, a critical decision for landowners may be to gain maximum salvage value by harvesting immediately after a fire or to rely on natural tree seeding by leaving some mature trees for their cone production potential, as well as bark beetle colonization.

Peter Kolb *has been the Montana State University Extension forestry specialist since 1997. He conducts research on a variety of forest restoration practices including post wildfire recovery and the role of salvage and sanitation logging. Peter can be reached at peter.kolb@mso.umt.edu.*

What Scientists Know About Free-Roaming Pet Dogs and Cats

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such as impulsiveness, aggression, cognitive decline, delusions, hallucinations, schizophrenia, and bipolar psychosis. Epilepsy, brain cancer, and rheumatoid arthritis are other outcomes strongly associated with *T. gondii*.

A second exception is for pregnant women who are infected and can also pass the parasite to their fetus and a developing brain. The third exception is when *T. gondii* causes a retinal infection of the eye, with severe cases producing vision loss.

Animals closely associated with humans can act as reservoir hosts that spread parasites to wildlife. Cat fleas (*Ctenocephalides felis*) have been found on 138 mammal species, including porcupines, rabbits, weasels, skunks, coyotes, foxes, raccoons, bobcats, shrews, rats, and mice. Wildlife that uses anthropogenic habitats is at the highest risk. Dog fleas (*Ctenocephalides canis*) have been reported on 31 mammal species, including coyotes, foxes, bobcats, weasels, rats, mice, and voles.

Cat and dog fleas infest mammals that free roam, indicating the breakdown of barriers between wildlife and invasive reservoir species will increase spillover at the interface between wildlife and domestic pets. Cat fleas are incredibly host-generalist, exhibiting a host range among the broadest of all ectoparasites.

Wildlife mortality from infectious diseases routinely goes undiscovered unless it is purposely targeted for monitoring.

Influence of Pet Owner Attitudes

Studies on dog-control measures used around the world found that regulations for pet exclusion or pets-on-leash mostly resulted in low compliance by owners. Researchers discovered that many owners:

• value their animal's freedom to explore more highly than wildlife conservation.

• have no other suitable options for pet exercise.

• estimate the probability is low for being caught or fined.

• believe their pets don't significantly harm the environment.

• perceive other owned pets as causing more harm than theirs.

• consider pet ownership and its impacts as a part of nature.

• see no actual evidence of harm.

Regulations

State-level regulations in Oregon, Washington, Idaho, and Montana do not speak to domestic cats except for their protection from cruelty. Dogs are often regulated as noise or at-large nuisance, or danger if they threaten or injure humans, livestock, and other domestic animals. Wildlife species that are Federal or State listed as endangered and threatened are regulated against harm. Washington can criminally charge any dog owner whose pets pursue, harass, attack or kill any hoofed wildlife species. Counties are authorized to write their animal control ordinances and could address human and wildlife health concerns if so desired.

Migratory birds are federal trust resources initially afforded protection under the Migratory Bird Treaty Act, which prohibited the "take" of migratory bird parts, nests, and eggs. Those regulations are currently under review after changes by former authorities. ■

Ed Styskel *is a Certified Wildlife Biologist and member of the National Woodland Owners Association. Now retired from the U.S. Forest Service and private consulting, he and wife Elly own 26 acres of forest and wetland in Pend Oreille County, WA. He leads the Selkirk Alliance for Science (www.selkirkscience.org, or Facebook @SelkirkScience), a Washington nonprofit based in Newport, WA, whose amateur and professional scientists advocate an increased understanding of the nature, value, and integrity of science to benefit our communities. He can be reached at edstyskel@gmail.com.*

Emerald Ash Borer in Oregon

By Alex Gorman, Assistant Professor of Practice
Oregon State University

On June 30th, 2022, Dominic Maze, Interim Manager of Biological Sciences for the City of Portland Environmental Services noticed several ash trees in decline in front of an elementary school in Forest Grove, Oregon, while picking up his kids. Upon further inspection, Maze noticed several metallic-green, flying insects around the trees. Maze, an invasive species biologist, recognized these insects as most likely being the invasive wood-boring beetle, the emerald ash borer (EAB). Maze alerted the appropriate authorities at the Oregon Department of Agriculture (ODA) and the United State Department of Agriculture Animal and Plant Health Inspection Service (USDA Aphis), and both agencies identified and confirmed the first known introduction of the emerald ash borer in Oregon, as well as the West Coast of North America.

The emerald ash borer was first detected in North America in Detroit, Michigan in 2002; dendroecological studies suggest that EAB was likely introduced in the mid to late-1990s. The emerald ash borer is native to Eastern Asia and is commonly thought to have arrived in North America via wooden packing materials, as many previous invasive plant pests and pathogens have.

As the name implies, the emerald ash borer is an insect pest on ash trees in the genus *Fraxinus* in the olive and lilac family, Oleaceae. In its native range, the emerald ash borer is of little concern and caused minimal damage to the ash trees that are native to Eastern Asia. However, in North America, EAB has a 95% chance of killing ash trees upon infestation, equal to more than 100 million trees killed across 33 states since the mid to late 1990s and making the emerald ash borer North America's most severe and costly invasive species. Several eradication efforts have been attempted in multiple US states and Canada, but none have been successful. There are about 70 species of ash throughout the world, 16 of which are native to North America, but there is only one that is native to the Northwest, ranging from the southern Sierra Nevada mountains in California up to southern British Columbia, the Oregon Ash, *Fraxinus latifolia*. Oregon ash dominates seasonal wetlands in western Oregon lower elevation valleys and is a common streamside tree in mixed forests; 80% of Oregon's native ash trees grow below 1,000 feet in elevation.

Ash is a common street tree planted throughout much of North America, and the Northwest is no different. Green ash (*Fraxinus pennsylvanica*), white ash (*Fraxinus Americana*), European ash (*Fraxinus excelsior*), and Raywood ash (*Fraxinus oxycarpa*) are all common municipal and landscape trees that are susceptible to an emerald ash borer infestation and subsequent mortality.

The emerald ash borer, a species of flat-headed wood borer, is small. Measuring a quarter to half-inch long and only an eighth of an inch wide, it is much smaller than most of our common, green insects in the Northwest. Being that it is so small, EAB can be a very cryptic insect that is hard to detect. It is not uncommon for an EAB infestation to go unnoticed for two or three years, only becoming apparent when trees display noticeable symptoms. Ash trees with an emerald ash borer infestation will commonly display a declining and thinning crown, epicormic sprouting, and bark splitting. Upon further inspection, D-shaped exit holes and serpentine galleries can be found. Woodpeckers will often flake off the bark of ash trees to feed on the emerald ash borer, creating the appearance of "ghost" trees.

The introduction of the emerald ash borer foreshadows potentially grave ecological and economic costs. Oregon ash is commonly found shading rivers and streams up and down its native range. The loss of riparian ash will likely cause the once-shaded waters to heat up, causing problems for our already endangered species of salmonids that need cold waters to thrive and reproduce. In Oregon, it is not uncommon to find that some stands are almost entirely composed of ash in the overstory. The high density of ash trees in these stands raises the question of what trees can be planted to replace ash, as well as how to prevent invasive plants from filling the now open growing space.

The emerald ash borer poses a financial threat to communities, homeowners, and landowners. Trees are expensive to remove, and once they die, they become brittle and therefore threaten public health. The cost of removing these trees often falls to the owner of the property on which the ash stands. Many experts believe we cannot get rid of the emerald ash borer, but we can slow the mortality of ash trees. The concept of Slowing Ash Mortality, or SLAM, is aimed at keeping our ash trees alive as long as possible and by doing so reducing the financial cost of the emerald ash borer.

However, not all is doom and gloom when it comes to the emerald ash borer. Several insecticide treatments provide anywhere from 1 to 3 years of protection; it should be noted that some insecticide treatments can be costly to apply and many treatments are not available over the counter. Furthermore, parasitoid wasps, which pose no threat to humans, may be an option for emerald ash borer management in the Northwest where EAB numbers may be low. These parasitoids feed on the eggs and larvae of the emerald ash borer and over time, theoretically, cause a pest population decline, and the wasps and pests form a predator-and-prey relationship.

Managing the emerald ash borer is a complex task that spans many sectors. In Oregon, a statewide emerald ash borer task force, led by the Oregon Department of Agriculture and facilitated by the Oregon Invasive Species Council, has been tasked with collaboratively determining how to manage this invasive pest. Currently comprised of over forty agency partners, including state and federal agencies, academic institutions, non-profits, and municipalities, the Oregon EAB Task Force learns more each day about how to manage the emerald ash borer and the future of our ash. ■

TreeSmarts: Answers to Your Tax Planning Questions

TreeSmarts: Answers to Your Tax Planning Questions appears every other issue in Northwest Woodlands. *The column is edited by John P. Johnston, a partner, CPA, and CMA with Bancroft Buckley Johnston & Serres LLP in Seattle, Washington. He is a member of the AICPA, IMA and WSCPA.*

Send in Your Tax Question

Do you have a question that relates to accounting, business, or tax planning? If so, send it to tax expert John Johnston (jjohnston@bbjsllp.com) and he will answer it in the next scheduled column.

The Trouble with S-Corporations

S-Corporations, or S-Corps, are the most popular form of a business entity after the Sole Proprietorship. They provide a good liability shield, help avoid the double taxation issue C-Corporations can cause, and allow a taxpayer to avoid significant payroll taxes, just to name a few benefits. But there are some very common and pervasive mistakes that people make when using an S-Corp, and they can be costly.

The S-Corp needs to be respected as a corporation. This means holding annual meetings (if not more frequently), keeping minutes, and making sure the Articles of Incorporation and By-laws are in good form and updated for law changes when applicable. It also means making sure you do not comingle personal assets. For example, the business 1) needs to have a checking account, and 2) that account should not be used regularly for the owner's expenses (or vice versa). Shareholder distributions are another area where people trip up. Distributions must be proportionate to ownership so if you get to the end of the year and realize they are out of balance, something needs to be done to correct that.

The expense side of things causes mistakes to happen and garners tighter IRS scrutiny. You may be aware that active shareholders are required to have wages, giving rise to payroll taxes and reporting. But did you realize that 'active' can include Board participation? Also, wages must be paid at a reasonable rate, comparable to what a business would pay a third party for services rendered (this concept is a source of great audit findings). Another regular mistake is that shareholders' health benefits are supposed to be included on line 1 of their W-2.

Expense reimbursements can be unexpectedly tricky as well. The corporation must have what is referred to by the IRS as an "accountable plan" (a quick search on their website will help define that term for you). If an accountable plan does not exist, or if proper documentation is not kept, the reimbursed expenses can be reclassified as income to the shareholder. The home office, particularly prevalent with the pandemic, should be handled carefully, including that to take a deduction for a

home office it is supposed to be used exclusively for the business.

The most complex area of non-compliance, and subject to close IRS scrutiny, is shareholder loans. If this is not correctly done the shareholder loan can be deemed a second class of stock, which will terminate your S-election. If shareholder loans are necessary, whether payable to or receivable from the shareholder, they should 1) be well documented with a formal note, 2) have a firm deadline, 3) should be performing, and 4) require interest at a rate equal to or greater than the Applicable Federal Rate (AFR). The AFR is a regularly updated rate published by the IRS that is the minimum that can be charged. IRC §7872 establishes a set of rules that if at least the minimum rate is not used, then the loan is determined to be a "Below Market Rate Loan". In this instance, the AFR will be used to impute the portion of the loan that is deemed to be interest and give rise to taxable interest income. Reporting of interest paid and received when the shareholder is a cash basis taxpayer while the S-Corp is on an accrual basis is complicated and beyond the scope of this article.

Shareholder loans payable to a shareholder also play an important role in determining basis, and the deductibility of losses. A shareholder can only deduct losses passed through from the S-Corp to the extent they have a remaining stock basis plus any debt basis. In other words, should a shareholder run out of stock basis but the business incurs losses, they can loan money to the corporation and deduct those losses to the extent of their debt basis. Of course, if losses have been deducted against the debt basis and the debt is repaid, that will trigger taxable income to the shareholder. This is another important reason to have a written loan document. Without such a physical note that taxable income on repayment would be ordinary income. But with a written note, it is classified as capital gain, which comes with favorable tax rates. By the way, unlike in a partnership, guaranteeing the debt of the S-Corp does not give the shareholder a debt basis. It must be a bona fide loan.

Hopefully, you have made none of the foregoing mistakes, which would put you in the minority and on solid footing for tax compliance. But if you have made a mistake or two, I strongly suggest you take immediate steps to correct the problem(s). The ramifications can be significant. ■

Disclaimer: To ensure compliance with requirements imposed by the IRS, any tax advice contained in this communication was not intended or written to be used, and cannot be used, for the purpose of (i) avoiding tax-related penalties that may be imposed on the taxpayer under the Internal Revenue Code or applicable state or local tax law, or (i) promoting, marketing or recommending to another party any tax-related matter(s) addressed herein.

Twig Tales

Pesky Pests

By KEN BEVIS

Headlines screamed: "Giant Garnet Killer Beetle-Bee Invades Cascadia"!

This insect is bad news, voraciously eating trees, shrubs, and small pets. On Gastly Island it ate everything, except groundhogs. And it packs a potentially lethal sting, thought to have killed a zoo elephant at Port Gumbo, where it likely emerged from a shipping container full of peanuts and vodka.

I planned a visit to Sunflower Farms on the WiggleWag River in NW Cascadia. Before visiting my landowners, I always check for possible issues. I clicked the geo-referenced database for WiggleWag and big red WARNING lights flashed, "GGKBB INVASION", exactly at Sunflower farms.

I called Dr. Buggy Spok from our FDCNRAFSDIPILP (Forestry Department of Coordinated Natural Resource Agency Forestry Services Division Insect Pests Integrated Landowner Program). He recently had a call from the landowner, Junie Bug, on the WiggleWag where she had seen some unusual red insects on her trees. Spok leads our crack team of Bug Busters (slogan, "Who Ya Gonna Call?"). I called the bug-eyed, no-nonsense, intelligent science geek. He answered, "Spok here. Speak." so, I did and blurted out the scenario. "You do Stewardship in a crisis? That is illogical" spoke Spok. "Maybe I can help?" I responded.

Spok paused, then said, "Yes. Meet you there. I'll bring gear and reinforcements."

I got there first and met June Bug, the amiable farm manager. June has run the place for decades, growing corn, pumpkins, and trees. She showed me cedars and giant cottonwoods down along the river and we chatted about birds and insects. She mentioned possible GGKBBs, (having seen a poster) and told me she'd called someone at the government but wasn't sure if the call got through.

Down by the river, there stood huge cottonwoods with broken tops and obvious hollow stems. "What excellent habitat trees" I exclaimed when suddenly, two figures appeared. Clad in full protective suits and large backpacks, one of them spoke, "Greetings. I am Dr. Buggy Spok, and this is my colleague Dr. Kerwin ZoBrainey. We're here for the Giant Garnet Killer Beetle Bee and our data indicates the GGKBB is nearby. Most likely it's in a hollow tree, Bevis, do you know which one?"

I knew and pointed. We staked out the cottonwood and agreed we'd get right to it after eating our delicious ZoBrainey take-out lunch, featuring Zobrisket®, Buzzard Beans, and special roadkill sauce. Seems Kerwin, a Professor of Salient Forestry-type Stuff from NW Cascadia University near Neverlit, started a takeout restaurant, combining his deep interest in BBQ and sustainable living through legally salvaged roadkill. (His possum special is a real crowd-pleaser after being featured on a food podcast called, "Eat 'em and Weep").

I leaned back, staring up at the big, hollow cottonwood. The thick hazard suit was very warm, my belly full, and my eyes heavy. I watched the beautiful, leafy canopy, relaxing into the moment when…..

We hear buzzing, it's the GGKBB! We jumped into action using climbing ropes to scramble up the hollow tree. I had to go first, rappelling into the core chamber. I carefully descended, scanning the rough sides for the dreaded GGKBB, when there she was!

The much-feared beast clung to the side and was below me. I had my flame thrower ready but started with a capture net and some sticky string. I eased down to the giant insect; it was at least a meter long and had a serrated switchblade stinger protruding from her formidable abdomen. The creature cocked her massive head to look as I moved into position. I readied my net. She followed the movement of my hands with a steady unblinking, compound-eye gaze. I made my move. She countered with jujitsu-like swiftness, grabbing my net in her two front claws, and swinging the deadly stinger at my face. Thanks to my fitness and safety training provided at FDCN-RAFSCSFDFSP, I quickly countered her moves and found myself in a face-to-face death embrace. Back and forth, we fought as we dangled in the middle of the tree. From above I heard Spok and ZoBrainey yell. I looked up to see a spider web thread holding a big hypodermic needle. With a swift move of a free hand, I pulled it from the air, and thrust the needle deep into the beast's head, injecting right between all 40,007 eyes. That did it. She suddenly became friendly and began licking my face. I got out my auxiliary net, wrapped it gently around her and they began to pull the vital specimen towards the sky. And then….

"Ken. Ken. Wake up. There's something on the tree" Said Spok in real-time. We went over and leaned in close. On the side of the trunk was a buzzing, rice-grain-sized bug with a slight red shine to the outside. "Is that it?" I asked "Yes!" chimed Spok and ZoBrainey in unison. "It's the queen." I was shocked and let out a sharp exhale, right on the bug, and that killed it! My Zo-breath, with extra spicy entrail sauce, whacked the GGKBB. ZoBrainey sauce extracts are potent organic insecticides!

We did it. The rest of the colony was destroyed using ZB sauce derivatives and GGKBB was never found in Cascadia again.

Spok and ZoBrainey won the annual IckNoble Prize for Solving Global Bad Things. The spray, "ZB #221" is now marketed as an insecticide and a delicate body wash. I was cited in a footnote and accepted a 2-for-1 coupon for ZoBrisket®, an adequate reward for a humble public servant, even if I did save civilization. ■

KEN BEVIS *is the Stewardship Biologist for the Washington Department of Natural Resources Service Forestry program (WADNRS-FP). All characters in Twig Tales are (slightly) based on real people. Let me know if you have any ideasat Ken.Bevis@dnr.wa.gov. I might have a story in mind with you in it.*

An Introduction to Root Disease Management in the Pacific Northwest

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or crossed lines. Record the species and diameter of affected trees.

Long-term control of root disease fungi is challenging and varies depending on the tree species and fungal species present. Depending on the fungi present, the root disease can persist on a site for decades unless control measures are taken. The two primary strategies to manage forest root diseases are to remove the pathogen or limit its means of spreading and reduce pathogen survival. Remember, all root diseases must spread through root-to-root contact, where an infected root of a tree or stump contacts a healthy tree root. A good rule of thumb for root disease rate of spread is 1-2 feet (radially) per year, except for black stain and Port-Orford-cedar root diseases which can spread faster.

Managing root disease by limiting the spread means breaking up the contact between healthy and infected trees. This can be done by thinning and removing stumps. You can also plant and manage resistant or immune species between root disease pockets and healthy trees; however, this can be challenging as it is very difficult to determine if a tree is healthy or infected if it does not have above-ground symptoms. After harvest, if susceptible trees are planted in root disease pockets, seedlings will eventually become infected, and damage in the new stand may even be more extreme than in the preceding stand.

Table 2.

	Laminated root rot	Armillaria root disease	Heterobasidion root disease	Black stain root disease	Port-Orford-cedar root disease
Douglas-fir (coastal)	1	2	3	1	4
Douglas-fir (interior)	1	1	3	3	4
Fir (grand, white)	1	1	1	4	4
Fir (Pacific silver)	2	2	1	4	4
Fir (noble, red, subalpine)	2	2	2	4	4
Hemlock (mountain)	1	2	1	3	4
Hemlock (western)	2	2	2	3	4
Incense-cedar, juniper, redwood	4	3	3	4	4
Larch (western)	2	3	3	4	4
Pine (ponderosa, Jeffrey, lodgepole)	3	2	2	3	4
Pine (knobcone, sugar, white)	3	2	3	3	4
Port-Orford-cedar	4	3	3	4	1
Redcedar (western)	4	2	3	4	4
Spruce (Engelmann)	2	2	3	4	4
Spruce (Sitka)	3	2	3	4	4

1 = severely damaged, 2 = moderately damaged, 3 = seldom damaged, and 4 = not damaged. Ratings based on field observations in the Pacific Northwest.

It can take decades for a root disease to die out of an area. Management of individual trees for vigor and favoring/selecting less susceptible species may lead to the reduction or elimination of a particular root disease on a site (Table 2). Planting or favoring hardwoods can help reduce disease after several decades, especially on sites affected by laminated root rot.

Root diseases can be sneaky, which is why you need to be familiar with the tree species in your forest and the overall health of your forest. Incorporate monitoring for insects and diseases into your forest management plan. You could do this on the ground (hiking or driving) or by looking at updated satellite imagery of your property (using a platform such as Google Earth). If you notice an area in decline, ground truth it and try to determine what's causing it. If you're stumped, reach out to your consulting forester or your local Extension forester for assistance. The earlier you catch an issue like root disease, the better you can manage it in the future.

To learn more about the identification and management of specific root diseases in the Pacific Northwest, visit the Know Your Forest Learning Library Forest Health page at https://knowyourforest.org/learning-library/forest-health. You can also download the very helpful publication "Managing Insects and Diseases of Oregon Conifers" (EM 8980) from the OSU Extension Catalog at https://catalog.extension.oregonstate.edu/em8980. ■

Alicia Christiansen *is an OSU Extension forester serving Douglas County. She works with a wide variety of audiences, most often small woodland owners, to provide education and outreach for forestry and natural resource subjects. She enjoys helping landowners gain forest management knowledge and experience through site visits, workshops and tours. Alicia can be reached at alicia.christiansen@oregonstate.edu.*

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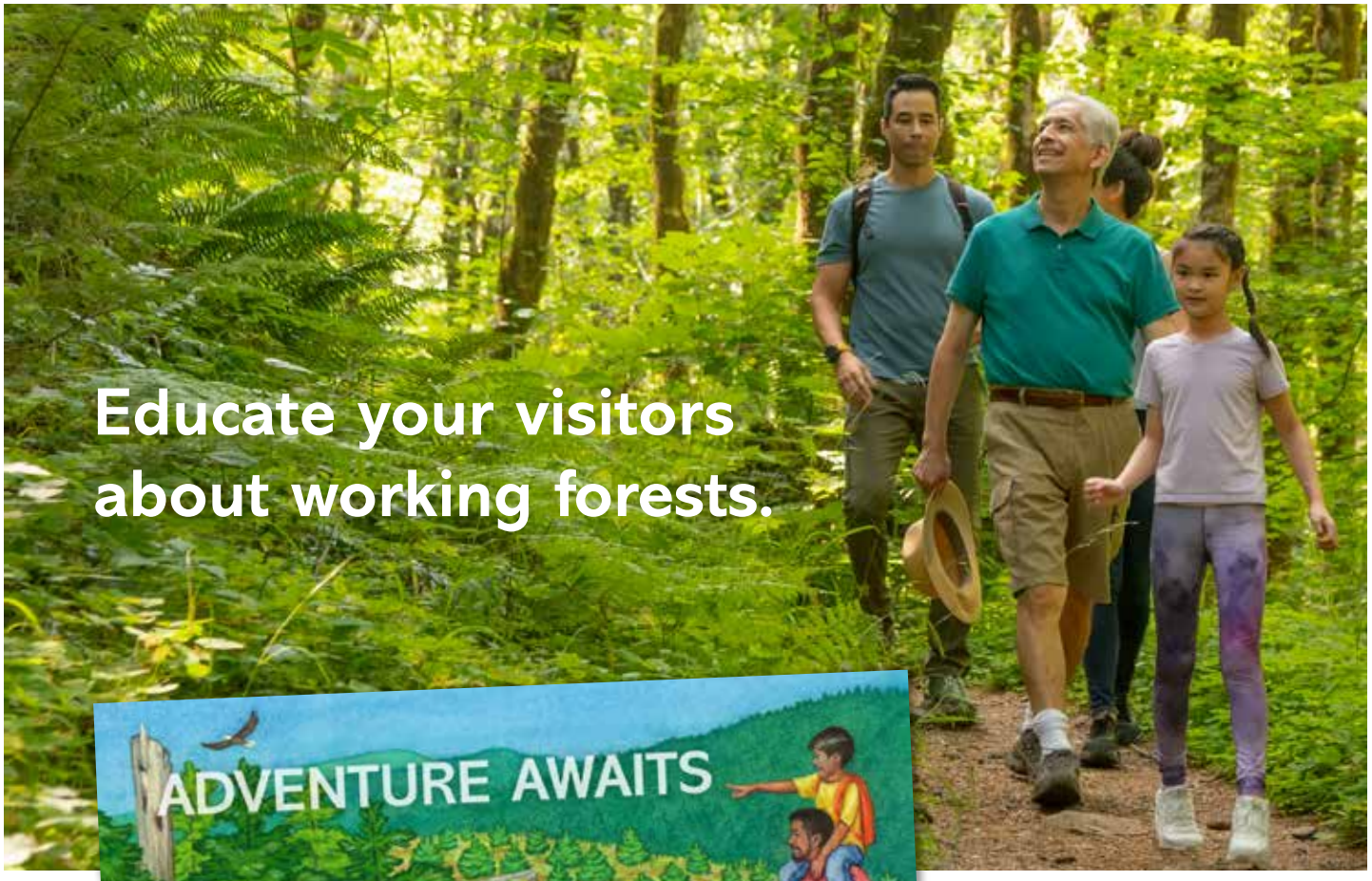

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