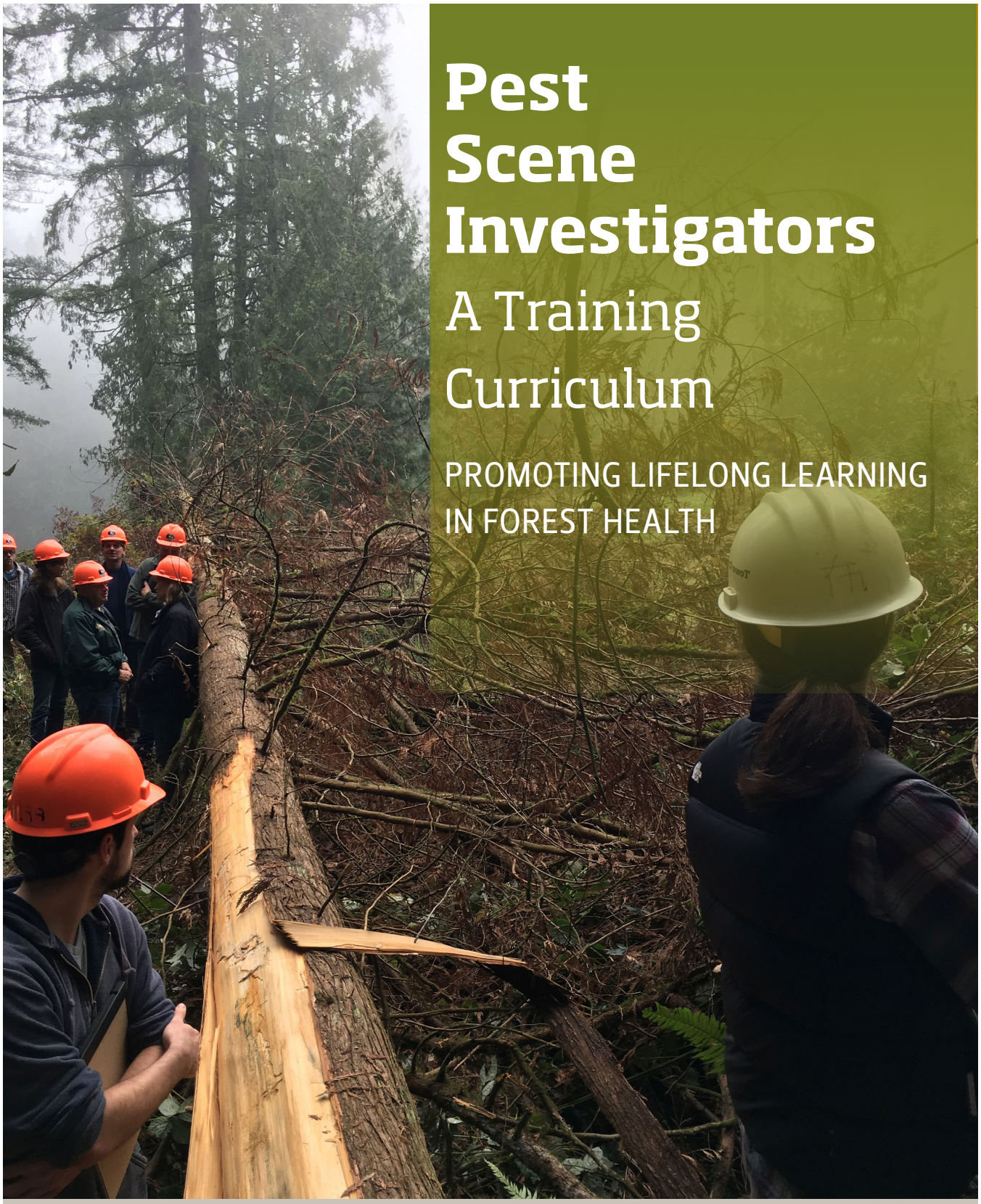

Pest Scene Investigators

A Training Curriculum

PROMOTING LIFELONG LEARNING IN FOREST HEALTH

EM 9161
March 2017

OSU Forestry & Natural Resources
Extension Program

Oregon State University

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Published March 2017.

Cover Photo: Brandy Saffell, © Oregon State University

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Overview: Pest Scene Investigator training

Purpose of the curriculum

This curriculum was created as a resource for OSU Extension foresters, educators, natural resource professionals, landowners, and others wishing to increase their ability to assess and mitigate forest health situations. The Pest Scene Investigator curriculum is to be used in conjunction with:

- *Field Guide to Common Diseases and Insect Pests of Oregon and Washington Conifers*. 2006. Goheen, E.M. and E.A. Willhite. R6-NR-FID-PR-01-06. Portland, OR: USDA Forest Service, Pacific Northwest Region.
- *Managing Insects and Diseases of Oregon Conifers*. EM 8980. 2009. Shaw, D.C., P.T. Oester and G.M. Filip. Corvallis, OR: Oregon State University Extension Service.

Photo: Dave Shaw, © Oregon State University

How this curriculum is organized

This curriculum includes an Instructor's Guide for those leading Pest Scene Investigator (PSI) training sessions. The guide details goals, equipment, locations, discussion questions, teaching guidelines, and the field exercises used in the training. Chapters 1 and 2 are designed for participants. These chapters provide information and pictures that explain important strategies and techniques for detecting problems affecting forests.

Training objectives

- Foster woodland owner confidence and skills regarding identification and management of the most common forest health problems in Oregon.
- Increase landowner ability to assess a forest stand condition and make management decisions based on personal management objectives.
- Train local groups of PSI volunteers in order to build local expertise in the area of forest health-related issues. Trained volunteers will have the skills and confidence to be available to assist OSU Extension agents, other technical professionals, and neighbors with surveys, diagnosis, and management recommendations for forest health problems.

Audience

The primary audience for PSI includes Master Woodland Manager (MWM) volunteers, woodland owners, and natural resources professionals with forest health interest and experience. Local OSU Extension agents may choose to include Master Naturalists, Master Gardeners, or other individuals with a unique interest in forest health situations.

Instructor's Guide

Photo: Paul Oester, © Oregon State University

Pest Scene Investigator training

Instructor's Guide: Pest Scene Investigator

Introduction

The intent of the PSI Training is to provide participants with a sound method for assessing the causes of poor tree health using field diagnosis and assistance from OSU Extension's Forestry and Natural Resources program, create an awareness of common local forest health issues, and craft management options that are dependent on landowner objectives.

In particular, we hope to inspire an interest in the iterative lifelong learning process that is needed to fully gain experience with the various forest agents that cause problems for trees, including abiotic factors like drought, forest pathogens, forest insect pests, and animal damage.

The PSI training curriculum provides information and skills in diagnosing the cause of poor tree health or mortality and taking appropriate management steps for one's own property. We also provide practical exercises so participants can build confidence in their ability to make cursory management recommendations for landowners based on the landowner's unique management objectives. It is not our intention to create experts in home landscape assessments or experts at insect and fungi identification.

Room setup

No room is necessary. The training is designed to take place exclusively in the field.

Total time needed

6 hours

Required equipment

Each participant should receive:

- *Field Guide to Common Diseases and Insect Pests of Oregon and Washington Conifers*. 2006. Goheen, E.M. and E.A. Willhite. R6-NR-FID-PR-01-06. Portland, OR: USDA Forest Service, Pacific Northwest Region.
- *Managing Insects and Diseases of Oregon Conifers*. EM 8980. 2009. Shaw, D.C., P.T. Oester and G.M. Filip. Corvallis, OR: Oregon State University Extension Service.
- Hand lens 10x
- Pest Scene Investigator handouts:
  - ❑ Service Ideas (page 19)
  - ❑ Diagnosis of Tree Problems (page 27)
  - ❑ Lifelong Learning—"Where do I go from here?" (page 29)
  - ❑ A summary of signs and symptoms (page 31)

The instructor should also supply:

- Clipboards
- Pencils for each participant
- Copies of case study exercises
- Pulaski, shovel, or trowel(s)
- Work gloves
- Pole pruner
- Hand or short ax
- Hard hats
- First aid kit
- Camera
- Binoculars
- Brown paper bags for collecting samples

Delivery method

- Field tour
- Field activities
- Field discussion
- Field evaluation of sick trees

Delivery method (continued)

- Digging, clipping, chopping, and slicing available trees to find signs
- Diagnosis of tree health in the field and identification support

Learning objectives

At the end of Pest Scene Investigator training, participants will be able to:

- **Survey a scene:** Assess forest type, condition, and stand health.
- **Check for clues:** Identify signs and symptoms.
- **Identify the culprits:** Discern between an insect, disease, abiotic factor, or combination.
- **Sentence the offender:** Make management recommendations based on landowner objectives.
- **Rehabilitate:** Identify resources for additional help and follow-up.
- **Communicate:** Share findings with OSU Extension faculty and report hours and actions to PSI coordinator.
- **Keep learning:** Access resources to find new issues and research.

Behavior objectives

Participants will:

- Conduct evaluation of a tree that appears to be in poor health.
- Be able to use a standard process for diagnosing tree health issues, including using available resources (provided guides), equipment, and knowing who to contact for further assistance.
- Explain local forest health issues.
- Assess tree condition and possible causes of poor health using the Diagnosis of Tree Problems form (page 27).
- Continue to practice tree health evaluations on their own property.
- Identify the common forest insect pests and pathogens in their region.
- Assess the importance of climate in current forest health conditions.
- Evaluate trees upon request and discuss hypotheses with OSU county Extension agent and other MWM/PSI participants.
- Integrate their training in forest health assessment into their MWM volunteer service.

Content outline

- Issues that influence tree health
  - ❏ Forest pathogens: root rot, stem decay, cankers and rusts, foliage diseases, and mistletoes
  - ❏ Forest insect pests: bark beetles, defoliators, sap-sucking insects, and terminal or branch insects
  - ❏ Abiotic factors:
    - Herbicide damage, mechanical injury, and pollution
    - Climate effects: drought, winter frost, and extreme weather
    - Nutrient deficiencies: nitrogen, phosphorous, potassium
- Introduce host landowner and have him or her explain land management and ownership history, land management objectives, and the forest health situation at each field site visited, including when damage was noticed, stand condition and history, and what kind of damage occurred.
- Discuss site and stand assessment as it relates to tree and stand health (i.e., soils, stand history, aspect, elevation, topography, species composition, tree age and size, crown class, crown ratio, and tree vigor indicators).
- Discuss tree symptoms and signs, damage patterns, and context related to diagnosis.
- Explain how local and regional weather events and trends can affect tree health.
- Discuss how to find information about local forest health issues (e.g., the Oregon Department of Forestry [ODF] or United States Forest Service [USFS] annual aerial survey website, and the annual Forest Health Highlights publication).

- Guide the participants through the diagnostic process for determining forest health issues, including:
  - ❑ *How was the problem discovered and reported?*
  - ❑ *Which tree species are affected?* Is it one species or several different species? Are some individuals less affected than others? What is the condition of adjacent trees?
  - ❑ *What are the symptoms?* Examples include a dead tree with no foliage, red or yellow foliage, reduced height growth, small needles or leaves, needle or leaf feeding signs, webbing, galls, thinning crown, abnormal growth or brooming, resin flow, sawdust, wind-thrown trees.
  - ❑ *Where is the damage located and what is the pattern of damage?* For example, is the damage to just one year of needle growth, scattered branches, one side only, just the top, or the whole tree?
  - ❑ *Are there any obvious causes?* For example, could fire, lightning, flooding, the wind, animals, bulldozer grading, or logging activity be responsible for the damage?
  - ❑ *Are there fungi, insects, or mistletoe present?* Are there any signs of a possible causal agent? Is the causal agent the primary problem or secondary? For example, could insects be infesting trees weakened by disease?
  - ❑ *Examine the roots.* Is there any indication that root problems are the cause?
  - ❑ *Examine stems, twigs, and leaves.*
  - ❑ *Examine growth rate (diameter and height) for signs of decline.*
  - ❑ *What is the stand or landscape pattern of damage or tree problems?* Examples include: more severe in some areas, scattered trees or groups, widespread, localized or patchy, all trees dead at one time or dying over time (i.e., all stages of tree decline and death). What is the pattern on the land (e.g., wet area, riparian zone, south slope, hilltop, or frost pocket)? Is the pattern of damage linked to these landscape features?
  - ❑ *When was the problem noticed?* Is there any herbicide or fertilizer use, other cultural practices, or unusual weather events?
  - ❑ *What are the site conditions?* Are the soils shallow? What are the slope position and aspect?
  - ❑ *Are there indications of shallow water table, poor drainage, or flooding?*
  - ❑ *What is your best guess and recommendation?* Include sources of assistance.

Background resources

Use the chapters in this curriculum for some background on the process of diagnosing tree problems in the field (Chapter 1) and forming management decisions (Chapter 2). You can also refer to Appendix A for a list of print and digital resources. Definitions for forest health terms can be found in *Field Guide to Common Diseases and Insect Pests of Oregon and Washington Conifers*.

Sample agenda

An in-depth sample agenda is available in Appendix B.

9:00 a.m. Welcome, introduction, distribute materials

9:30 a.m. Visit Site 1 (meet landowner, problem diagnosis, management discussion)

10:30 a.m. Refreshment break and transition to Site 2

11:00 a.m. Visit Site 2 (meet landowner, problem diagnosis, management discussion)

12:00 p.m. Lunch and case study exercise

1:00 p.m. Transition to Site 3

1:30 p.m. Visit Site 3 (meet landowner, problem diagnosis, management discussion)

2:30 p.m. Closing discussion (common local issues, lifelong learning, service ideas)

3:00 p.m. Transition back to starting point

3:30 p.m. Class ends

Outdoor field exercises

The entire training is meant to take place in the field. The focus is on visiting multiple sites with diverse forest health issues. The group will diagnose the problem with the assistance of the landowner and expert instructors.

At least three site visits are ideal. At the first site, the instructors walk participants through the diagnosis and management process, introduce the field sheet, and prompt example questions to ask landowners. At the second site, participants are asked to do more of the work themselves, guided by instructors, and at the third site, the participants are left to do the assessment on their own. For example:

SITE 1:

Participants are brought to a site where a landowner has some trees in poor health or that are already dead and show symptoms of a problem. Instructors walk participants through the use of the Diagnosis of Tree Problems form (page 27) to guide questions and the assessment. The landowner is present to help with answers to key questions. Each participant will:

(1) walk up to the tree, evaluate condition, and assess symptoms;

(2) voice what the symptoms indicate; and

(3) look for signs, beginning in the crown and moving to the leaves, twigs, bole, and roots.

Make sure the participants use the Diagnosis of Tree Problems form as they go through these steps.

Note: This may involve digging and chopping roots, chopping away bark around the trunk or root crown, and cutting foliage and twigs to examine the various plant parts (such as needles and buds). Discuss context and patterns if applicable. Once the diagnosis is complete and a satisfactory conclusion is made, then we turn to a discussion of commonality of local problems and how to manage these issues.

SITE 2:

Participants are brought to a second site where the landowner has some trees in poor health or that are already dead. Instructors give some guidance about where participants should start (e.g., questions to ask landowner, prompt to use form, clues about where to look, and answering questions). Students should be allowed to make their own evaluation and the instructor should not rush the process or give students the answer too fast. Participants have a set amount of time to make their diagnosis (e.g., 30 minutes). Once time is up, participants share their diagnoses, instructors give answers, and the group has a discussion on how to manage the issue or issues affecting the trees.

SITE 3:

Participants are brought to a third site where the landowner has some trees in poor health or that are already dead. Instructors give little to no guidance. Participants (either individually or in groups) have a set amount of time to make their diagnosis (e.g., 40 minutes). Once time is up, participants share their diagnoses and management ideas. Instructors will give feedback and answers.

Case study exercise

In Chapter 2, there are four hypothetical case studies of forest health issues on private landowner properties, each located in different regions of Oregon. This exercise can be done over lunch in small groups. You can use all four case studies or select one that corresponds to the region in which the training takes place. Although these are not actual, real-life scenarios, these hypothetical situations are based on common problems in each area and as such can be used to discuss local forest health issues and the various management options for each issue.

Host agent prep

- Recruit instructors and professionals.
- Familiarize instructors with objectives, content, agenda, and structure of session.
- Communicate with PSI participants to confirm location and time.
- Make sufficient copies of all handouts.
- Prepare refreshments (if applicable).
- Identify field sites.
- Organize field tour transportation.
- Dry run field tour with instructors.

When selecting field sites, consider the following:

- Three sites with distinct forest health problems are ideal. Typical issues are drought, animal damage, root disease, and bark beetles.
- Two or three sites can be on the same property (i.e., within walking distance or a short drive).

- At each site, after diagnosing the problem, the group should consider the big picture. Walk through the area to gain an idea of the landscape setting and management options.

Instructor guidance

This training is important for building knowledge about forest and tree health. It is important that the instructor is enthusiastic and makes this training practical and fun. The information participants will learn and the skills they attain will be extremely important in developing their management plan for their own property, and also working and communicating with landowners in their neighborhoods during volunteer activities. We emphasize field activities because this is the best way to learn. Only by repeatedly seeing forest health issues in the field can one really learn.

Alternative delivery methods

This training is designed for the field. It may be possible to deliver the content online, or in class with visual aids, but the key feature is learning diagnosis in the field. The recommendation is to focus on field exercises, although a portion of the day could be in a classroom setting.

Suggested homework or class prerequisites

Homework can be useful in introducing participants to the training materials before the training takes place. The following online resources present forest health issues detected by the Aerial Detection Survey program and provide a good starting point for identifying local issues.

- Oregon Department of Forestry, Forest Health: http://www.oregon.gov/ODF/ForestBenefits/Pages/ForestHealth.aspx
- U.S. Forest Service, Aerial Detection Survey: http://www.fs.usda.gov/detail/r6/forest-grasslandhealth/insects-diseases/?cid=stelprdb5286951

PSI training evaluations and PSI tours

After participants complete the PSI training outlined in this curriculum, it is highly recommended to have them complete a training evaluation (see Appendix B). The evaluation results will provide valuable feedback to the training coordinator and instructors on how to improve program delivery.

PSI tours are field outings that can be arranged any time after a PSI training. We suggest planning a PSI tour when a forest health issue becomes relevant, such as an insect outbreak, a drought year, or several occurrences of a disease of interest. These outings are meant to keep PSI participants engaged and learning about forest health issues, give them an opportunity to see forest health issues in the field, and prime their understanding of how to manage these issues by having conversations with peers, Oregon State University Extension faculty, and state or federal forest health experts. It is a good idea to invite PSI training participants, master woodland managers, and local landowners. Also, consider arranging for instructors from OSU Extension and state and federal agencies to help guide the conversation. A sample PSI tour flyer can be found in Appendix B.

Pest Scene Investigator Service Ideas

There are many ways you can contribute to your forestry community as a PSI volunteer. You can also tailor your service so that it suits your talents and interests.

Be a good example

One of the best things you can do is practice good forest stewardship on your own property. Neighbors and passersby will see what you are doing and are more likely to be influenced by those practices than by being told to do something by an outside agency or group.

Contribute to citizen science

Citizen science increases scientific knowledge through crowdsourcing (i.e., data collection by citizens). There are several established citizen science programs you can tap into. Some examples include:

- **iNaturalist**—Biodiversity monitoring (www.inaturalist.org)
- **Ecoblitz Events**—Regional species monitoring events (theintertwine.org/blitz)
- **The National Phenology Network**—Phenology monitoring (usanpn.org/natures_notebook)
- **CoastWatch**—Beach mile monitoring (oregonshores.org/coastwatch.php5)
- **COASST**—Dead seabird monitoring (depts.washington.edu/coasst)
- **NatureMapping**—Wildlife monitoring (naturemappingfoundation.org)
- **Project Budburst**—Phenology monitoring (www.budburst.org)
- **CoCoRaHS**—Rain, hail, and snow network (www.cocorahs.org)

Be a first detector

The United States Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS) monitors pests and diseases. If you see a pest or disease of concern, you can report the pest to this agency. Contact the Oregon State University forest health specialist or your local OSU Extension agent first to see if it is appropriate to report your find. Either contact will work with you to file a report to the proper agency. You can also use the Oregon Invasive Species Online Hotline (www.oregoninvasiveshotline.org) to file a report, as these reports are monitored by state and federal forest health experts. If you are interested in learning more about invasive pest detection, consider becoming an Oregon Forest Pest Detector (OFPD). This training will teach you how to identify and report high-priority, invasive forest pests. Visit the OFPD website to learn more: pestdetector.forestry.oregonstate.edu.

Help your OSU Extension Forestry and Natural Resources Agent

People who complete Pest Scene Investigator training can help Extension agents organize forest tours, workshops, or meetings with landowners. There may be an opportunity to have your Extension agent connect you with an Oregon Department of Forestry Stewardship Forester or U.S. Forest Service scientist if they need help in your area. Another group that often needs help with insects and diseases are Master Gardeners. You might consider helping with their plant clinics and answering "sick tree" questions. Contact your local OSUExtension office to find out how to get involved.

Union County Master Woodland Manager Butch Tansey has helped Union and Wallowa OSU Extension agent Paul Oester teach several basic forestry short courses in Wallowa and Union counties. Tansey also uses

his knowledge of insects and disease management from PSI training to help woodland owners learn how to implement practical forest health practices on their land.

Talk to your neighbor

Help your neighbors understand basic forest processes and connect neighbors with Extension and organizations like the Oregon Small Woodlands Association (OSWA). These steps will help ensure that more lands are well managed and that the work you have done on your property pays off.

Benton County Master Woodland Managers Mike Albrecht and Greg Vollmer created a new social network for local forest owners called the Forest Owners Discussion Group. The group of 10 to 12 landowners meets monthly to tour each other's properties and give peer reviews of what they see being done by their fellow group members. The concept involves a lot of encouragement and some constructive criticism, all for the betterment of local woodland stewardship.

Go on a field call

One of the most common questions OSU Extension foresters get is regarding sick or dying trees. You might not feel comfortable going on your own right away, but joining someone on field site visits and helping answer those questions will greatly alleviate pressure on OSU Extension, and will help you hone your PSI skills. Remember to fill out the Diagnosis of Tree Problems form and take photos when making a field call. You can use these records to double check with your local OSU Extension forester if there is anything you are unsure about.

Share a story

Maybe you would rather write than talking to folks. If so, we always welcome first-hand reports of identifying and managing for an insect or disease. These articles might go in a local newsletter. Contact MWM coordinator Tiffany Fegel (tiffany.fegel@oregonstate.edu) to see about writing an article.

Share photos or videos

Photos and videos of insects and diseases in a forest setting are really useful educational tools for others. Please share your photos and/or videos with us.

Work with kids

Let's get kids outside! You might want to partner with 4-H and lead a group on your property. You can also work with your local school district. High schools that have forestry programs and forest health modules are interested in partnering with local woodland owners. Other organizations that work with children, such as Forests Today and Forever of Cottage Grove, regularly host student groups and are always looking for instructors. Talk to your county OSU Extension forester about the Oregon Natural Resource Education Program (ONREP) and other local youth education opportunities.

As a retired school teacher, master woodland manager Bonnie Shumaker knows how much a child can take away from just a few hours in the woods. She and her husband Bob have hosted hundreds of local elementary school children at their tree farm over the past several years. Together, they developed a learning loop with stations where the children learn about how trees grow, observe animal habitats, or simply draw or write about their impressions of the forest. The Shumakers have recruited a number of Washington County master woodland managers to help lead activities on their school tours, creating a high-quality, volunteer-run learning experience. If you've ever attended one of these tours, you've seen that all the kids abide by Bonnie's number-one rule: have fun.

Chapter 1

Photo: Paul Oester, © Oregon State University

Diagnosing a problem

Chapter 1: Diagnosing a problem

Diagnosis of tree problems

Correct diagnosis of a tree problem sets the stage for appropriate management. A dead or sick tree will often not require any action and will not always be a threat to adjacent trees or forests, but knowing the reason a tree has an issue is extremely important.

There are exceptional field guides to insects, diseases, and other agents that kill or damage trees in the Pacific Northwest, thanks to the efforts of federal forest health protection, state forestry departments, universities, and Extension services (See Appendix A). This plethora of information is available on the Internet, as are assessments of ongoing regional mortality events. In this chapter, we have adapted and expanded the steps needed to diagnose insect and disease damage that is outlined in most field guides. Correctly diagnosing the probable cause of death helps determine whether that mortality is really a threat to your trees and property. The death of an individual tree in the forest does not necessarily portend the death of all the other trees.

Steps in diagnosing tree damage and mortality

We have developed the Diagnosis of Tree Problems form (see page 27) that asks for the following information.

Determine the tree species impacted

Note what species are affected and whether some individuals are less affected than others. *Trees to Know in Oregon* (https://catalog.extension.oregonstate.edu/ec1450) is an excellent resource for identifying tree species. Check the condition of adjacent trees. One of the most critical question in assessing damage in the field is to properly identify the tree species affected. Is it one species or several different species that are involved? Are some individuals less affected than others? What is the condition of trees that are adjacent to dead and dying trees? Are these adjacent trees the same species? These questions are critical to the eventual diagnosis of whether this problem is a threat to your remaining trees and property. For example, many trees are planted in regions where they are not native, which may or may not work well for the trees. The tree might be dead and covered with insects or disease fungi, but the underlying cause may be that it is not native to the region and may not be adapted to the local climate.

Identify the tree symptoms

Symptoms are how the host expresses the disease or insect invasion (whereas signs are expressions of the agent itself). Examples include a complete loss of foliage, red or yellow foliage, reduced height or diameter growth, small needles or leaves, galls, thinning crown, abnormal growth (e.g., brooming or thickening of the branches), resin flow, and wind-thrown trees that have no roots (i.e., root balls). For general diagnosis of problems in the field or nonlaboratory setting, the tree species and symptoms really begin to narrow the list of potential problems.

Defoliated ponderosa pines exhibit the "lion's tail" effect, where foliage is confined to the tips of branches.

Photo: Dave Shaw, © Oregon State University

Locate the actual damage

Determine the part of the tree that is actually affected. For example, if the foliage is discolored, is the damage limited to year-one needles, scattered branches, one side of the tree, just the top, or the whole tree? Herbicides and nutrient problems can be expressed in distinct patterns on the foliage. Some foliage diseases only impact one age class of foliage at a time. The Douglas-fir canker will commonly cause topkill and whole-branch kill, often called flagging when the foliage is red. The actual damage is at the interface between the dead parts of the tree and live parts, where there is an active fungus growing into the live bark. Root disease causes the entire tree to decline and die with distinct above-ground symptoms, but the damage is below ground and out of sight. Some bark beetles cause distinct dieback at the top of the tree (topkill) which is a key diagnostic feature. What is the bottom line? Find the location where the damage is causing the symptoms. You need to know this to determine the cause.

Search for obvious causes of damage

These causes may include large or small animals, frost, lightning, mechanical injuries, herbicides, flooding, stock animals, bulldozer grading, soil trenching, thin or rocky soils, or fire (prescribed or wildfire). It is easy to focus on the tree and forget about the surroundings. A forester once visited a person who had a dead pine with red foliage in the yard. The tree did not appear to be sick beforehand but was suddenly dead for no apparent reason. The forester asked about a dead patch of grass under the tree. "That's where my son changed the oil in his car," the landowner said. The forester concluded that the drained oil reached the tree roots and likely caused the tree's decline.

Locate the causal agent

In a crime situation, the causal agent is often called the perpetrator. A fungal fruiting body, bark beetle galleries, exit holes, or chewed and webbed needles are all signs of a causal agent. Signs can aid in identifying or even discovering the perpetrator, but it is not always easy to find the signs. One may need a shovel, ax, Pulaski, binoculars, or chainsaw. However, once you do find a fungus or insect, you have to determine whether it is the primary causal agent or a secondary organism attracted to the declining tree. For example, we often find the Douglas-fir beetle in recently dead trees infected with laminated root rot. Was the tree killed by Douglas-fir beetle and now the entire stand is threatened? Or did the tree have extensive laminated root rot and the beetles just took advantage of a stressed tree? This is a common phenomenon in western Oregon and Washington. Although some trees may be killed by Douglas-fir beetle, this does not typically mean adjacent Douglas-fir stands are threatened by beetles. It may mean that there is some root disease and the Douglas-fir beetle mortality is localized. Before you react, find out the causal agent.

This photo shows fir engraver beetle galleries on grand fir.

Photo: Steve Bowers, © Oregon State University

Examine the roots

Roots and the root collar can shed light on many problems. When the issue cannot be diagnosed any other way, get the Pulaski out and begin to dig. Clearing the area around the root crown, digging around the crown, and following a root or two about a meter out can help determine if root diseases are involved, or if root feeding by insects or animals is involved. It is also possible that the tree was planted improperly and was "J" rooted, which is when a tree planter forces the seedling so hard into the ground that it causes the tap root to bend upward. Those seedlings often die in a few years but sometimes can survive for decades. Then suddenly the tree succumbs from lack of root expansion because the roots can't keep up with the top.

A Douglas-fir with root disease.

Photo: G.W. Wallis, Bugwood.org (CC BY-NC)

Identify the landscape pattern of damage

This can be a key factor in determining the threat to your stand and in identifying what is causing the problem. Is your situation a problem associated with a specific landscape feature? For example, is the problem more severe in some areas? Are the trees scattered, in groups, localized and patchy, or mostly on south slopes? Root disease areas are often called centers because the fungus is localized to a patch of ground and will radiate outwards in all directions. In addition, bark beetles often kill trees in groups because of the pheromone communication system they use to attack trees en mass. Are bark beetles on a property because of an outbreak, landscape-level drought, poor timing with pine logging in the area, overstocking, or a combination of factors? Low areas with poor air drainage, especially during wet springs, are sometimes vulnerable to needle disease. Also, wet areas, riparian zones, hilltops, and frost pockets are often associated with a specific disease or insect issue. Always be aware of the pattern of damage on the landscape.

Establish when the problem was first noticed

Are there any possible connections to herbicides or fertilizer use, other cultural practices, or an unusual weather event? Did all trees die at one time or is the pattern a chronic dying over time? One way to separate bark beetle flare-ups from root rot centers is that with bark beetles, the trees tend to die all at once or over several consecutive years, whereas root rot centers in a stand will exhibit all stages of tree decline and death. In addition, snags left by a bark beetle infestation will be in similar condition, whereas root rot-killed snags will be in different stages of decay.

Who is the culprit?

With all this information, it is now possible to identify the causal agent behind the mortality, and perhaps more importantly, to deduce the reason why your tree died. In many cases, the insect or disease found on your tree is a symptom of some underlying issue that weakened your tree or trees. With this knowledge, it is possible to determine whether the causal agent is a threat to your remaining trees, or whether the dead tree or trees in question were just unlucky. Knowing the facts can save you time and money, and prevent stress regarding something that is not a serious threat. At the same time, you can also use this information to act promptly to prevent further damage and reduce long-term impacts.

Fir broom rust is apparent on this subalpine fir.

Photo: Dave Shaw, © Oregon State University

Pest Scene Investigator

Diagnosis of Tree Problems

Adapted from *Pests of the Native California Conifers*

Person completing form:_____

Date:_____ Landowner:_____

Location:_____

1. How was the problem discovered and reported?

2. What is the stand or landscape pattern of damage or tree problems? *(e.g., more severe in some areas; scattered trees or groups; localized or patchy; all trees dead at one time or dying over time; or all stages of tree decline and death. What is the pattern on the land? Is the site a wet area, riparian zone, hilltop, or frost pocket?)*

3. When was the problem first noticed?

4. Is there any possible connection to herbicides or fertilizer use, other cultural practices, or an unusual weather event?

5. What tree species are affected? *(One species or several different species? Are some individuals less affected than others? The condition of adjacent trees?)*

6. Are there any obvious causes? *(e.g., fire, lightning, flooding, wind, animals, bulldozer grading, logging damage)*

7. What are the symptoms? *(e.g., dead tree with no foliage, red or yellow foliage, reduced height growth, small needles or leaves, needle or leaf feeding signs, webbing, galls, thinning crown, abnormal growth (e.g., brooming), resin flow, sawdust, wind-thrown trees)*

8. What is the location of the damage on the tree? *(e.g., Is damage to just one-year needles, scattered branches, one side only, just the top, or the whole tree?)*

9. Are there any fungi, insects, or mistletoe present? Is there any sign of a possible causal agent? *(Do you think the identified agent is the primary or secondary problem? For example, insects infesting trees weakened by disease)*

10. Examine the roots. Is there any indication that root problems are the cause?

11. What is your diagnosis and recommendation, including sources of assistance? *(The presence of multiple agents makes it difficult to discern the primary cause of damage and mortality, and it is seldom that we find silver bullets to forest health issues.)*

Pest Scene Investigator

Lifelong Learning: "Where do I go from here?"

Identifying and understanding tree health issues, and especially all of the various insects and pathogens that can influence trees, is not something we learn in one day. Even the experts that work on these topics require years of training and experience before they become experts. However, this does not mean you cannot become an expert yourself. You are out in the woods observing all of these things and you probably know more than you realize. The key is to put all of your observations together to solve your forest health puzzles. A lifelong learning approach is what makes a great forest manager and observer. There are numerous books, field guides, and technical guides produced by agencies and universities that can aid in identification and management of forest pests, and knowing where to go is half the battle. Much of the PSI training is about knowing where to go, or which book to use to look up an insect or disease. The reference section of this curriculum has a plethora of insect and disease resources in the Pacific Northwest, including books and websites. Often, all it takes is utilizing these resources or asking some strategic questions on an online search engine to find your answer.

Making a formal collection

Documenting the pests and diseases you observe while continuing your education is a great way to stay involved and keep a developing record of what you have seen. The two main methods to accomplish this are photography and preserved collections.

Photography

Photography is a great way to document issues and to develop a collection of all the insects and pathogens you encounter. There are several guidelines and tips to formalizing a photography collection:

1. Create a filing system that will allow you to manage all of your photos on your computer. Each image or photo series should be stored in a separate file, under headings that make sense to you.
2. Written notes (e.g., a diagnosis form) should go in the file with the photos. The document should include the date and location of the photos and any other information that seems important. Other things you might include are tree species and a description of the extent of the issue.
3. It may be difficult to identify the insect or pathogen, but collecting information is important and will help in pest identification. You can send photos and diagnosis forms to an expert to assist in identification.
4. Collect a series of photos that capture the scene. For example, take photos of the general setting, the overall tree, and the insect or fungus at various scales (i.e., as close as your camera will allow and scaled back).
5. Consider storing your photos in a PowerPoint slideshow for future reference. There is room to take notes, draw arrows to certain features in the images, and showcase a series of related photos.

Collecting and preserving insect specimens

Collecting and preserving insect specimens is an old tradition and it can be a great hobby, especially if you enjoy looking at interesting creatures. It is very helpful to work with a dissecting microscope that can scale from 10X to 40X. Learning how to collect, mount, and preserve insects requires some background reading. Most insect field guides and other basic entomology texts have a chapter on how to make a collection. For example, there is a great website from the University of California, Davis that describes how to make an insect collection with video aids: http://entomology.ucdavis.edu/News/howtomakeinsectcollection_647/. To preserve your collection you need a cool, dry place for storage. In some cases, it is important to place a mild pesticide in the storage area to prevent small beetles or moths from getting in and eating your specimens (e.g., you could put mothballs or a cut portion of a dog's flea collar in the box with the insects or fungi and put the box in a sealable plastic bag.)

Collecting and preserving fungal disease agents

Fungi differ from insects in that they are easier to catch! Collecting fungi also requires research on techniques before you begin. Do not put your fungi in a plastic bag (unless it is fully dried) because rot and mold will quickly take over. Brown paper bags and cardboard boxes are ideal. For guidance on sample storage and preservation, consult the *Collecting and Preserving Fungi Manual*: http://www.cassavabiz.org/production/proddocs/FUNG-SCR.PDF

Join an organization

There are a few organizations in Oregon that offer the opportunity to gather with fellow insect and fungi enthusiasts for various continuing-education events. Community gatherings are a great place to ask questions, bring samples for identification, and share your interest with others. Consider joining a meeting or field trip with:

- Oregon Mycological Society: http://wildmushrooms.org/
- The Xerces Society: http://www.xerces.org/
- North American Butterfly Association: http://www.naba.org/chapters/nabaes/index.html
- Bug Guide (online community): http://bugguide.net/node/view/15740

You can also join Master Woodland Manager field tours, Master Naturalist nature walks, and Master Gardener classes. Contact your county Extension forestry agent to learn more about connecting with these and other groups.

Help with pest identification

Need assistance deciphering what you have found? The best way to get a pest identified is to collect the specimen and send it to a lab or expert. In Oregon, this is best done through the OSU Extension Plant Clinic in the Department of Botany and Plant Pathology (http://plant-clinic.bpp.oregonstate.edu/)

Oregon State University
OSU Plant Clinic
1089 Cordley Hall
Corvallis, OR 97331-2903

541-737-3472

Before submitting or collecting specimens, it is best to visit the clinic website or call staff members to make sure you follow their collection protocol and are aware of any costs associated with processing a sample. Explore their "How to submit a sample" web page before beginning your collection process:

http://plant-clinic.bpp.oregonstate.edu/submit

Alternatively, you can send photos and diagnosis form to your OSU Extension agent, Master Gardener clinic, the OSU Extension forest health specialist, or the Oregon Department of Forestry forest pathologist/entomologist. The photos should show the general scene, the tree species, the damage, and close-up images of any organism you find with an object to indicate scale. High-resolution photos are ideal, and fuzzy or dark photos generally are not useful. If it is a common disorder, the agent will typically be able to identify the cause. Getting a site visit from a professional is difficult and may require a fee, but for trees adjacent to houses or in urban areas, an arborist may be the best option. Refer to the International Society of Arboriculture website: http://pnwisa.org/

Pest Scene Investigator

A summary of signs and symptoms of forest insects and diseases

Experts diagnose a tree's problems by looking at symptoms, signs, patterns, and context.

Symptoms are the host's expression of disease or an insect infestation, and can include sparse foliage, yellow foliage, resin flow, pitch tubes, swellings, branch dieback, and crown dieback.

Signs are an expression of the agent, such as a fruiting body on a needle, a conk on a trunk, insect galleries, chewed or webbed needles, and pale, web-like growths known as fungal mycelia.

Patterns are found on individual trees and within groups of trees; they emerge when just a portion of the tree or trees is affected (e.g., top and bottom branches), or when only the windward or exposed side of a tree is affected, or when only needles of a certain age show signs of distress. Patterns also emerge when only certain tree species are affected, or only trees of a certain age, or in mortality progression (e.g., slow or rapid).

Context is the setting for the observed damage and involves factors such as geographic location, topographic location (e.g., elevation, aspect, floodplain, ridgetop), stand or site history (e.g., windthrow events, management activities, seed source), timing (e.g., foliar discoloration in fall verses spring), weather history, and forest condition or characteristics (e.g., pure or mixed species, stand structure, stand density).

Some symptoms and signs for several causal agents are outlined below:

Bark beetles, wood borers, and ambrosia beetles

- Symptoms
  - ❑ Fading foliage (i.e., yellow to brown to red-brown)
  - ❑ Complete crown fading
  - ❑ Branch death or flagging
  - ❑ Top kill
  - ❑ Rapid crown fading, usually in the spring or early summer
  - ❑ Woodpecker feeding activity on bark
- Signs
  - ❑ Pitch tubes or streaming on the bark
  - ❑ Boring dust or frass on the bark and base of tree
  - ❑ Beetle galleries under the bark
  - ❑ Blue stain in sapwood (prominent on pines)
  - ❑ Beetle adults or C-shaped, white larvae under bark, or both
  - ❑ Pinholes (ambrosia beetles) or larger holes (wood borers) in wood

Defoliators

- Symptoms
  - ❑ Foliage looks singed from a distance
  - ❑ Thinning crown
  - ❑ Needles chewed or missing
  - ❑ Mined needles
  - ❑ Defoliation from the top down

■ Signs

- ❏ Larvae feeding on foliage
- ❏ Cigar-shaped cases on branches or in needles
- ❏ Larvae in groups or single
- ❏ Webbing on branches and needles
- ❏ Piles of granular frass amid foliage

Aphids, scales, and adelgids

■ Symptoms

- ❏ Thin crowns
- ❏ Loss of older needles
- ❏ Yellowing foliage

■ Signs

- ❏ White, crusty material on tree trunks and branches
- ❏ Sooty material on branch and between needles
- ❏ Hard and black, or fuzzy and white, scales on needles
- ❏ Soft-bodied, small aphids on needles, branches, or trunk

Terminal, branch, and root insects

■ Symptoms

- ❏ Dead shoot tips or terminal leaders on trees
- ❏ Shepherd's crook dead top on spruce
- ❏ Young trees mostly affected, up to about 30 to 40 feet

■ Signs

- ❏ Larvae in the pith of branch, terminal leader, or roots
- ❏ Pupal cells with shredded bark in wood of terminal leader
- ❏ Adult weevils or moths

Foliage diseases

■ Symptoms

- ❏ Yellowing foliage
- ❏ Speckled or blotchy foliage (yellow, brown, red, and orange discolorations)
- ❏ Red banding on foliage
- ❏ Foliage partially dead (especially at the tip)
- ❏ Dead foliage
- ❏ Dead foliage hanging on tree
- ❏ Lion's tail effect (current year foliage only)
- ❏ Crown appears burnt or is partially red
- ❏ Crown looks thin and sickly

■ Signs

- ❏ Small black dots, located on underside of needle, filling the tiny pores (stomates) of the needle
- ❏ Eruptions or pustules on needles (can be gelatinous)
- ❏ Small black or brown dots anywhere on needle surface

Canker diseases and rusts

■ Symptoms

- ❏ Annual canker
- ❏ Perennial canker
- ❏ Canker on branch or trunk
- ❏ Localized branch swellings and enlargement
- ❏ Branch death (flagging)
- ❏ Top dieback
- ❏ Resin flow
- ❏ Spindle-shaped swelling
- ❏ Hip cankers, or a swelling on the lower trunk that is the result of an old infection

■ Signs

- ❏ Eruptions of spore masses around canker
- ❏ Small black dots along margin of canker

Dwarf mistletoes

■ Symptoms

- ❏ Spindle-shaped swellings on branches
- ❏ Witches' brooms
- ❏ Clumped foliage
- ❏ Dead branches (flagging) and tops
- ❏ Deformed crowns
- ❏ Disease center in stand

■ Signs

- ❏ Small green or brown leafless shoots (1 to 12 inches long)
- ❏ Shoots with berries
- ❏ Basal cups, which are small, bowl-shaped structures where the mistletoe attaches to the trunk or branch and that remain when the mistletoe stem falls off

Chapter 2

Photo: Paul Oester, © Oregon State University

Managing a problem

Chapter 2: Managing a problem

Management options for landowners

One of the primary goals of this training is to prepare landowners to make informed forest health management decisions in the wake of tree damage or mortality on their property. Each site or stand will have distinct management issues, and therefore, it is impossible to list all relevant management options. The following are some key considerations in making forest health management decisions.

A healthy forest is a relative term, based on landowner objectives and tolerance for mortality. For example, landowners who are interested in maximizing wood production and have invested in reforestation and early stand management treatments such as precommercial thinning would typically have a low tolerance for mortality. However, landowners who are trying to create a forest with such old-growth characteristics as large snags and downed logs would likely embrace mortality up to a certain limit. Snags and downed logs also provide more cavity and nesting space, which may meet a landowner's objective to foster a greater diversity of wildlife. Many landowners don't like to see any tree mortality, but dead trees are a natural part of forest development and growth. A forest with some dead trees is not an unhealthy forest.

It's a good idea to assess the potential for the agent of damage to spread to other trees and forests. Some insects and diseases may cause damage or mortality but are localized and slow to progress. For example, dwarf mistletoe will cause growth loss and eventually mortality, but these impacts develop slowly and significant effects only occur in more advanced stages of mistletoe infection. Alternatively, insect pests can have rapidly accelerating populations, such as some bark beetle species and defoliators.

Western dwarf mistletoe on a ponderosa pine.

Photo: Dave Shaw, © Oregon State University

When dealing with health issues in your forest, you must determine the underlying cause of the mortality. Many pests and diseases, such as bark beetles, stem cankers, and Armillaria root disease are a signal that there is an underlying cause of tree stress affecting tree vigor. Examples of underlying causes include too many trees, root disturbance, soil compaction, drought, off-site planting, and tree wounding. Is the problem related to drought,

A commercial thinning operation underway in a second-growth Douglas-fir stand.

Photo: Dave Shaw, © Oregon State University

overstocking, an off-site species, or a species mix susceptible to a particular root disease? In most cases, forest insect pests are a result of something else that is stressing the tree. Some pests and diseases, such as white pine blister rust, laminated root rot, gypsy moths, and bark beetles, cause tree mortality despite ideal growing conditions. By identifying the cause of insect or disease activity, you can apply silvicultural treatments, such as thinning, sanitation cuts, salvage, and species management, to correct the situation and protect your forest from future risks.

If your property is showing elevated mortality and you think it is time to capture the economic value of the loss, you need to know something about the economics of removing the trees and the markets for the wood. In many cases, dead and dying trees will not pay their way out of the woods unless there is a large, concentrated volume. Long skidding distances and scattered trees are expensive to justify their removal alone, except for very high-value trees, such as large ponderosa pine. To make the sale economically viable, you will likely have to take other green trees. This is usually not a problem if thinning will be beneficial to the stand. Markets and their distance from the harvest area will also dictate what is economical. You will need to have markets that will take dead trees. If the trees have been dead too long, mills are usually not interested unless it is a pulp-fiber market. For example, in eastern Oregon, pine killed by bark beetles is not worth harvesting and trying to sell to a sawmill. This is because bark beetles carry a blue stain fungus that gets in the sapwood, and mills are not interested in buying the logs even though there is no breakdown or damage to the wood itself. The blue stain lowers the wood grade or quality (though some specialty markets might buy it). Holes made by wood borers that move in once bark beetles have infested trees also reduces merchantability. For landowners with dead trees from pests, the key is to remove the trees as soon as possible (within a year is best). Small trees should be removed even sooner. Access is an important consideration; if your dead and dying trees are in an area without good access roads, the cost of building or upgrading a road might not be worth their value.

Be proactive. Most forest insect and disease issues can be prevented or minimized with good silviculture. A forest health inventory is a good first step. Determine the inherent forest health issues already present in your forest, such as dwarf mistletoe or root disease. Once these issues are identified, use silvicultural tools to reduce insect and disease impacts each time you enter the forest for harvest, thinning, or planting.

Armillaria mushrooms fruiting in the fall at the base of a Douglas-fir. This fungus causes *Armillaria* root disease.

Photo: Paul Oester, © Oregon State University

Know what triggers increased risk of insects and disease. For example, creating pine slash at critical times can dramatically increase pine beetle populations and result in tree mortality. Tree wounding can also cause an increase in heart rot, especially in true firs. In addition, consider the timing of your management activities, such as not cutting or pruning in spring to avoid attracting certain insects, like pitch moths and bark beetles (depending on region and host species). Timing is even more critical if your area is currently experiencing an insect outbreak. Use your knowledge of triggers to lower overall risk from insects and disease.

A western larch snag that now serves as wildlife habitat.

Photo: Dave Shaw, © Oregon State University

A lot of the management you will conduct to increase resilience and forest health can also improve wildlife habitat. You might consider leaving some dead trees, especially larger ones. These provide valuable food for wildlife (e.g., beetle larvae), as well as nesting habitat in cavities. When snags fall over, they retain wildlife value as down logs. Keep in mind that this is dependent on how long the tree has been dead, whether it is in an area experiencing an insect or disease outbreak, or if the tree poses a hazard to people or property. Trees that have been dead more than a year generally pose no hazard of breeding mortality agents, only secondary insects. Variable density thinning (i.e., non-uniform spacing, or leaving clumps and gaps) also enhances wildlife habitat, creating some more open areas, encouraging shrubs, and keeping some denser patches for hiding and thermal cover for deer or elk. Diversifying your species composition with patches of conifers and hardwoods where appropriate will also increase habitat diversity and encourage more wildlife species that rely on acorns, insects, and the complex structure of hardwood trees.

Management decisions also depend on your personal interest, knowledge, and equipment. If you have the interest and ability, you might want to salvage dead and dying trees for firewood, posts, and poles you can use around your property. Maybe you have equipment that you can use to salvage the trees at low cost. Perhaps you are interested in purchasing a small mill that can utilize the dead and dying timber on your property to make boards for barns, sheds, and other uses.

Finally, use the resources available. This includes getting ODF Stewardship Foresters, consultant foresters, OSU Extension agents, and Master Woodland Manager volunteers in your area out on the ground. Other ideas include taking classes at OSU Extension Tree School or an Extension forestry workshop. Also, you can get publications, online classes, or presentations (OSU Extension and Oregon Forest Resources Institute are good sources), and manuals (see Appendix A). Use these resources with your understanding of the information in this chapter to develop a forest health plan.

Case study 1: Central Oregon

Objectives and personal situation: Miranda Smith owns 100 acres of dry ponderosa pine forest in central Oregon. Smith is 56 years old and about to retire. She and her husband raised their three children on the property. All the children are grown and have moved away. Smith would like to create a healthy forest that is resilient to fire and climate change and provides wildlife habitat. Smith would ultimately like to leave the property for their children to enjoy. It would be great if any work on the property paid for itself. Supplemental income would be appreciated too.

Forest history: Prior to European settlement in the latter part of the 19th century, the dry ponderosa pine forest in central Oregon was much more open than today, with large expanses of somewhat patchy clumps of widely spaced, large trees. European settlement brought grazing, along with logging of most of the large trees, followed by decades of fire suppression. Most ponderosa pine forests today are much denser, lack the large tree component (both live trees and snags), and are more homogeneous. Fire history studies suggest that fires were quite frequent, about once every 8 to 15 years, and fire intensity was low. As seedlings and saplings became established, they were quickly removed with these frequent, low-intensity ground fires. Dry pine forests of today have missed multiple fire cycles and as a result, they have become overstocked with small trees ranging in age from about 40 to 80 years. Stands and natural landscapes lack their historical patchiness, horizontal and vertical diversity, and are more homogeneous in age class, size, and density, thus more prone to bark beetle attacks due to competition. These stands are also more vulnerable to high-severity wildfire because tree density is not only high, but the vertical and horizontal structures are continuous, which allows for fire movement into tree crowns.

Stand and forest condition: Scattered across this property are a few large, 150-year-old ponderosa pines intermingled with clumps of 60- to 80-year-old trees. The large trees average about one to three per acre while the younger trees are close to 400 to 600 trees per acre. The vigor of the older cohort has been declining for several years with some trees showing thinning crowns and flattened tops. The younger cohort is generally healthy but showing signs of declining vigor as well; diameter growth has shown a gradual decline over the past 10 years. Some younger trees have also died due to bark beetle attack.

Site description and productivity: Smith's property lies at about 4,000 feet in elevation south of Bend, Oregon, and is typical of many pine-dominated forests in the high pumice plateau of central Oregon. Precipitation averages about 20 inches per year and comes mainly as snow in winter. Summers are warm and dry, with brief high-intensity thunderstorms. Moisture distribution with these storms is spotty and averages about
1 inch throughout the summer. Soils are pumice, originating from the eruption of Mount Mazama (Crater Lake) and Newberry Crater. These soils have moderate to low organic material and grade into relatively unweathered pumice sand and

gravel. A finer-textured, buried soil is located around 1.5 to 9 feet below the surface. Height growth of ponderosa pine is slow for the first 50 to 80 years on these soils but accelerates once roots reach the buried soil beneath the pumice. These soils have a site index of 100 to 110 (100-year base). The topography is relatively flat to gently rolling, with slopes no greater than 20 percent.

Insects and diseases: On about a quarter of the property, several trees are infected with light to moderate levels of dwarf mistletoe. The Western pine beetle has killed individual, larger trees in the overstory in the past few years. Also, a few pockets of three to five trees have been killed by bark beetles where younger trees are dense. It appears that bark beetle activity is increasing.

Markets: Ponderosa pine logs are purchased on a price scale based on small-end log diameter. Larger logs are worth significantly more than small logs. A market for pine sawlogs is within reasonable transportation distance, but there are limited market alternatives (only one mill in the area). One key to profit is the distance to market; shorter distances provide higher net value because less of the profit is eaten up in hauling logs. In many cases, it is best to mix smaller logs with some larger logs to make the sale profitable. There is also a pulp market, but prices are at breakeven levels. Smith might also consider a firewood market and an export market.

Questions:

1. How would you describe what is going on at Miranda Smith's place (big picture)?
2. What management options would you provide to Smith given her goals for the property?

Case study 1: Answer guide

Current situation: Overstocking and fire suppression has resulted in too many trees per acre. The few overstory trees are in decline due to the high number of competing younger trees. Many of the trees, both old and young, are stressed due to lack of water and space, which is causing reduced vigor and beetle attacks. The high density has also created a high fire risk and has reduced wildlife habitat quality, as lack of sun and space has killed available forage and fruiting shrubs needed for deer, elk, and many songbirds.

Management strategies: Given the relatively low number of large trees and Smith's objective, you might recommend thinning heavily around the large trees, up to two drip lines beyond the canopy of those trees. Even those declining trees with mistletoe that might eventually die will provide important wildlife habitat (e.g., mistletoe brooms, snag creation, large downed logs). Alternatively, if economic values are more important, you could recommend selectively removing some of the low-vigor, overstory trees to capture some value. Pay attention to log markets to capture higher log prices.

Density, competition, and fire risk are a problem on this property. You can recommend thinning from below in those areas with merchantable timber. Leave-tree spacing should reflect a return harvest interval of 15 to 20 years when Smith would like some supplemental retirement income. Thinning should focus on leaving healthy dominant and codominant trees and taking the higher-risk trees and trees with heavier mistletoe. Along with the sawlog removal, smaller trees should be harvested for pulp or firewood or both to reach the proper spacing. Cost-share funding (consult with ODF stewardship foresters) will probably be available for thinning out nonmerchantable trees. Areas with smaller, noncommercial trees should be precommercially thinned to a moderate to light density to allow for early commercial re-entry to take advantage of markets for pulp, firewood, poles, and small sawlogs. Catching a good market will be the tipping point to harvest or not, unless tree mortality rates pick up. Smith probably should not wait for the larger trees to die from bark beetles if the maximum economic value is the goal. Bark-beetle-killed trees are usually not worth harvesting and transporting to the mill because of blue stain deductions.

Thinning should leave the healthy trees, those with long, full crowns, little or no damage, low dwarf mistletoe infection, and crowns with a dark-green color. Thinning the younger cohort will help provide the remaining older, larger trees with more growing space, which should improve their vigor and lower bark beetle risk. Space the younger cohort at a wider spacing within 30 feet of the larger trees. Thinning the younger trees will improve leave-tree vigor and diameter growth, and accelerate their trajectory to the larger log and higher value in time for Smith's retirement income needs. Smith should also be sure to manage the pine slash from any salvage, thinning, or harvest activities to prevent future bark beetle infestations.

Case study 2: Northeastern Oregon

Objectives and personal situation: Woody Woodman owns 100 acres of dry and moist mixed-conifer forest in northeast Oregon. Woodman is 60 years old and about to retire. He and his wife have three grown children living out of the area. Woodman would like to create a healthy forest that will grow well and provide some supplemental retirement income in the next 20 years and a legacy for his children.

Stand and forest history: Scattered throughout the stand are a few older trees but none are over 120 years old. Evidence of stumps from about 1905 suggests that ponderosa pine, Douglas-fir, and western larch were common. The present forest originated from a heavy cut or possibly a clearcut around the turn of the 20th century. A partial cut occurred in about the mid-1950s. Douglas-fir and grand fir show evidence of dead tops, most likely caused by western spruce budworm defoliation in the 1980s and 1990s. Studies of similar dry and moist, mixed-conifer forests in eastern Oregon indicate that prior to European settlement, these forests had a mixed-severity fire regime. Consequently, stand densities were lower, contained higher proportions of shade-intolerant species, such as ponderosa pine and larch, and were patchier in nature. Today, after a century of fire suppression, grazing, and multiple logging entries, these stands typically have higher densities (mostly shade-tolerant species such as grand fir), increased fuel loading, vertical and horizontal continuity of fuels (increasing the risk of higher fire severity or stand-replacing fires), reduced individual and stand-level growth and vigor, and greater susceptibility to bark beetles and pathogens.

Stand and forest conditions: There are 40 acres of moist, mixed-conifer forest on an east-facing slope and 60 acres of dry, mixed-conifer forest dominated by ponderosa pine and Douglas-fir on slopes facing south and west. The moist, mixed-conifer type is comprised of a dense understory of 30-year-old Douglas-fir (40 percent), western larch (20 percent), ponderosa pine (20 percent) and grand fir (20 percent). The overstory consists of a few 90-year-old Douglas-fir, larch, and ponderosa pine, at about 20 per acre. The drier ponderosa pine/Douglas-fir stand has an overstory of scattered trees, primarily 100-year-old ponderosa pine, with an understory of mostly clumpy, 40-year-old ponderosa pine (70 percent) and Douglas-fir
(30 percent). The overstory and understory in the moist, mixed-conifer forest appear healthy; however, radial growth has slowed. The overstory in the 60 acres of drier pine and Douglas-fir stand is declining and individual tree mortality has been increasing in all age classes over the past few years.

Site description and productivity: Located at about 4,100 feet in elevation, Woodman's tract is typical of many mid-elevation, mixed-conifer forests in northeast Oregon. Precipitation averages about 30 inches, mostly in the form of winter snow. Summers are warm and dry with some thunderstorms. Soils on the

drier south- and west-facing slope are residual in nature, mostly Hall Ranch stony loam of moderate productivity with a site index of 90 to 100 (100-year base). The moister stand has significant amounts of Tolo silt loam soils that characteristically have greater moisture holding capacity. These soils have a site index of 110 to 120 (100-year base) or higher. The stands are both on gentle slopes of less than 20 percent and easy for using ground-based logging equipment.

Insects and diseases: Western pine beetle has been slowly killing a few of the larger pines, and Douglas-fir beetle has killed several Douglas-fir trees. Pine engraver beetles are common in the area; thus, any pine slash or winter damage may cause escalated beetle populations and risk to standing pines. Mountain pine beetle is also a risk and can cause mortality in pine forests in this region. Also, due to the vertical and horizontal continuous forest structure, these stands are vulnerable to high-severity crown fires. A few of the western larch have dwarf mistletoe in their crowns. Western spruce budworm has caused some topkill in Douglas-fir and grand fir from the 1980s epidemic. Both western spruce budworm and Douglas-fir tussock moth are two aggressive defoliators common to eastern Oregon with a habit of periodic outbreaks. Armillaria root rot occurs on about 5 percent of the area in the moist, mixed-conifer stand.

Markets: Currently, there are limited markets for post- and pole-size material and pulp is a break-even situation. There is some market potential for small sawlogs, both domestic and export. The domestic market for sawlogs and plywood logs is profitable but not high.

Questions:

1. How would you describe what is going on at Woodman's place (big picture)?
2. What management options would you provide to Woodman given his goals for the property?

Case Study 2: Answer guide

Current situation: Woodman's stands are overstocked and under considerable moisture stress because of competition. This is compounded by the current drought situation, particularly for the drier forest area. Several of the overstory trees in the drier stand have been killed by bark beetles, which is symptomatic of moisture stress. He also needs to address the root disease issue in the cool, moist stand, primarily by converting the pockets of root disease to less susceptible species (e.g., larch).

Management strategies: Although markets are not optimal, you might want to recommend that Woodman move ahead and treat the drier stand now. He can watch the moister, mixed-conifer stand for any increase in insect or disease activity and try and catch a better market for treatment. Woodman is able to qualify for cost-share funds for thinning and fuels reduction so he decides to remove all the overstory trees and thin the understory using income from the overstory sale and cost-share dollars. His net income will be minimal at this time, but the stand treatment will lower the risk of future bark beetle attacks and fire and set the stand up on an accelerated growth trajectory such that he can expect to do a commercial harvest in 10 to 15 years. He will take advantage of the clumpy nature of the stand and try to maintain this feature as a treatment goal. From an income perspective, waiting until markets are more favorable for the moist forest will give Woodman the opportunity to treat the remaining 40 acres at a profit because of the better growth on this site, as well as a future commercial entry on the 60 acres currently treated. This watch-and-wait strategy will also provide Woodman the option to treat the moist forest earlier if insects, disease, or drought dictate action, though the timing of treatments will depend on the stresses they would put on currently drought-stressed trees.

Case study 3: Western Oregon

Objectives and personal situation: Forrest Silverman owns 100 acres of forestland in western Oregon. Silverman is 58 years old and plans to retire soon. He and his wife have three grown children living out of the area. Silverman would like to create a healthy forest that will grow well, provide some supplemental retirement income in the next 20 years, and leave a legacy for his children.

Forest and stand history: This forested property is located northwest of Corvallis, Oregon. Most of the current forests in this region are second growth due to logging, clearing for agriculture, or natural or human-caused wildfire. Fire return intervals here are longer than in eastern and southwest Oregon, or even in the foothills of the Cascades and Coast ranges in the Willamette Valley. Fire-ecology studies suggest that fires in the area of Silverman's property naturally occur once every century or more. Historically, clearcutting followed by burning was the primary harvesting strategy. Harvesting of trees was originally confined to areas that were within skidding distance to a mill or water. In the late 1800s, railroad logging began and continued until about World War II, when logging trucks and tractors became widespread.

Stand and forest conditions: The Silverman property includes:

- A 30-acre, 35-year-old plantation that was planted with Douglas-fir at 500 trees per acre after a small fire
- About 20 acres of 40- to 50-year-old western redcedar mixed with Douglas-fir, red alder, and bigleaf maple growing along a small stream
- A 10-acre, 40-year-old clear cut that never was planted and is currently a brush field.
- About 40 acres of 100-year-old Douglas-fir and redcedar left over from a heavy partial cut intermingled with 50-year-old red alder and some hemlock seedlings beginning to grow into the understory

Site description and productivity: The Silverman property lies at about 600 feet in elevation. The climate is wet, mild, and maritime, with average annual precipitation of 60 inches, which comes primarily in the winter as rain. Summers are relatively dry with only 6 to 9 percent of the total annual precipitation. Soils are moderately deep, with a high organic content and clay loam texture. Most of the property is low site II and high site III ground.

Insects and diseases: The 35-year-old Douglas-fir plantation has pockets of laminated root rot with Douglas-fir beetle attacking and killing a few trees each year. Occasional windthrown trees can be found within the root disease areas. The brush field has mountain beaver colonies concentrated in a 4-acre area and laminated root rot is common in the old stumps. There is some white speck heart rot in the Douglas-fir in the 100-year-old stand.

Markets: Good markets are available for small and large sawlogs of Douglas-fir, as well as red alder and western redcedar sawlogs. Pulp markets are modest and break even at best. Export markets are accessible for Douglas-fir only.

Questions:

1. How would you describe what is going on at Silverman's place (big picture)?
2. What management options would you provide to Silverman given his goals for the property?

Case study 3: Answer guide

Current situation: Silverman's 35-year-old stand is on a good site that is overly dense, although the laminated root rot is a problem if he wants to eventually harvest and replant the stand with Douglas-fir in the future. The brush field also has laminated root rot, though it's confined to 40-year-old stumps that are nearly completely decayed. The mountain beaver could be an obstacle in future reforestation. The 100-year-old stand has wildlife and timber value. The white speck heart rot will progress with time and should be considered in a management plan.

Management strategies: Silverman could let the 35-year-old Douglas-fir stand grow for another
10 to 15 years. This stand is on a good site and well-stocked, so any mortality should not significantly affect the overall yield. At the end of this time, the stand could be harvested and replanted with species that are immune to laminated root rot, including western redcedar, red alder, and bigleaf maple. Red alder is also a nitrogen-fixing species, so over a 25- to 40-year rotation, the root disease will be minimized and the site will have additional nitrogen for the next crop of Douglas-fir.

He could wait to site prep and plant the brush field. The root disease in this stand will eventually die out as the old stumps rot away, which should not be too much longer based on the age of the existing stumps. When the 35-year-old stand is harvested, some of the money could be used to site prep and plant the plantation and brush field. He could also trap the mountain beaver where present in the brush field prior to planting Douglas-fir.

The 40 acres of 100-year-old scattered Douglas-fir and western redcedar with red alder could be harvested or thinned now and sold as sawlogs both domestically and for export, then planted to a mixture of Douglas-fir and western redcedar to provide for species diversity. Additional species diversity could occur by protecting the western hemlock growing in the understory. The Douglas-fir has some heart rot defect, so converting the stand now to a vigorous young forest will help improve timberland values down the road. If Silverman has wildlife objectives, he could leave a few of the larger trees as snag and foraging trees.

If Silverman had old-growth objectives, this stand could be left to grow and develop for many more years, although the alder component will begin to break up as it gets older. If he decides to wait, his supplemental retirement income could come from the 35-year-old Douglas-fir plantation.

As for the Douglas-fir beetle issue, Silverman could consider using an application of MCH, which is a naturally occurring, anti-aggregation pheromone that discourages the build-up of beetle populations on logs and fallen trees by sending a message that the tree is full and that beetles should look elsewhere for a suitable host. An MCH treatment could help protect noninfested trees, particularly if salvage following storms needs to be delayed and there is an abundance of slash for beetle brood development.

Case study 4: Southwestern Oregon

Objectives and personal situation: Timber Woodlady owns 145 acres of mixed conifer and hardwood forest in southwest Oregon. Woodlady is 55 years old and thinking about retirement. She and her husband have two children. Woodlady would like to create a healthy forest that will grow well, provide some supplemental retirement income in the next 20 years, and leave a legacy for their children.

Stand and forest history: A few scattered, large-branched pines and oaks are remnants of an older age class, suggesting this forest was once much more open. High-grade logging first took place in the late 1800s, then again in the 1920s and '30s, and again in about 1950. As a result, there are three main age classes: a 130-year-old cohort of large, scattered trees; a 70- to 90-year-old cohort that originated after logging in the 1920s and '30s; and a 35- to 50-year-old age class that developed following harvesting in the 1950s. The 35- to 50-year-old age class consists of mostly dense, small, pole-sized Douglas-fir and Pacific madrone. Historically, fire played a major role in determining species composition, stand structure, tree density, and large, connected natural patterns, including openings. Fire reconstruction studies have found that stands similar to Woodlady's experienced frequent low- to moderate-severity fires, which occurred every 8 to 15 years, on average. Studies provide evidence that these forests historically were patchy across the landscape, with lower tree densities, larger individual trees, and a higher proportion of shade-intolerant species (such as pines and oaks). Fire-suppression efforts for more than a century created forests quite different from their historic range of variability, including:

- Greatly increased stand densities of small-diameter trees mixed with shrubs
- Elevated fuel loads (with vertical and horizontal continuity of fuels) resulting in higher fire severity
- Reduced individual and stand growth and vigor
- Greater susceptibility to bark beetles and pathogens

Current stand and forest conditions: Douglas-fir is the dominant tree species, mixed with varying amounts of ponderosa pine, incense cedar, sugar pine, California black oak, and Pacific madrone. Oregon white oak is found in areas with shallow or heavy clay soils, and bigleaf maple and alder are found along streams. North slopes support relatively productive stands dominated by dense, pole-sized, and small-diameter Douglas-fir and Pacific madrone with intermittent larger trees. Sugar pine and incense cedar are minor components. On south-facing slopes, productivity is lower and Douglas-fir dominates with some ponderosa pine, black oak, incense cedar, and Pacific madrone. Tree density is high but average stand diameter is lower than on north slopes.

Site description and productivity: Located at about 2,500 feet above sea level, the Woodlady property is typical of mixed-species forests at low to mid-elevations in southwest Oregon. Precipitation averages 35 to 40 inches a year, mostly in the form of winter rains. Summers are hot and dry with
10 to 15 percent of the annual total rainfall occurring during this time. Soils on north slopes are primarily McNull loams that are relatively productive, being moderately deep and well-drained. South-slope soils are a mixture of McNull and Medco soils and are lower in productivity. Medco soils have a dense clay layer that restricts rooting depth and can cause a perched water table, which is when groundwater accumulates above a water table due to impermeable soil, usually during winter and spring. This condition, where it occurs, increases ponderosa pine presence, which ultimately becomes the most common conifer on the site. Douglas-fir site index (50-year base) varies from 55 to 80 across the property, depending on aspect and soils.

Insects and diseases: Larger sugar pines are at risk from mountain pine beetles, pine engraver beetles, and white pine blister rust. Ponderosa pines are attacked by western pine beetle and pine engraver. Douglas-fir beetle is not common, but low-vigor Douglas-fir may be invaded by flatheaded fir borers, which act similarly to bark beetles. Although no major outbreaks are currently in progress, trees in overstocked stands and on marginal sites are at high risk, especially in drought years. Five percent of the area shows pockets of Armillaria root disease, as well as some blackstain root disease, which has killed several Douglas-fir trees across the property. White pine blister rust has often been found in sugar pine trees.

Markets: Markets for sawlogs have improved over recent years from very low, mill-delivered values to levels that provide a reasonable profit for the landowner. Minimum tree size for harvest is
8 inches diameter at breast height (DBH), which is the standard method of expressing the diameter of the trunk, or bole, of a standing tree. The pulp market is still low but good enough to provide a few dollars per ton to the landowner. A good firewood market exists. A pole market is available but intermittent.

Questions:

1. How would you describe what is going on at Woodlady's place (big picture)?
2. What management options would you provide to Woodlady given the goals of her property?

Case study 4: Answer guide

Current situation: Many of Woodlady's trees are in overstocked conditions. This has led to low-vigor Douglas-fir trees that are susceptible to outbreaks. It has also caused rapid spread of beetle infestations among multiple pine species. In addition to the insect issues, there are concerns about a few fungal diseases throughout the property (Armillaria, black stain, and white pine blister rust).

Management strategies: Within the next 1 to 5 years, Woodlady could implement a thinning in the overstocked, low vigor, and small diameter stands, aiming to retain the more vigorous and healthy Douglas-fir, ponderosa pine, and sugar pine. On south-facing slopes and ridgetops, it would be particularly strategic to keep pine to promote vigor and remove Douglas-fir, which becomes stressed in these environments. Low-vigor, dead, dying, diseased, or defective larger trees can be harvested as well. If possible, it would behoove her to combine thinning cost-share dollars with harvest revenues to meet the high cost of thinning small-diameter stands and capture all market potential by exploring firewood, pulpwood, and pole market opportunities. It would be a good idea to use whatever possible for personal use, such as firewood and poles.

Once the high priority stands are treated, you might advise Woodlady to work with other overly dense stands. Where justified economically, she could consider light commercial thinnings that target low-vigor, diseased, dying, and dead trees or clumps that need spacing. Where large Douglas-fir, sugar pine, and ponderosa pine are surrounded by a dense, competitive understory, she could thin around these large trees to reduce competition and improve leave-tree vigor and resistance to bark beetles and pathogens.

In root disease areas, she could create a small clearing of one-third to one-half an acre or larger depending on the size for the diseased pocket and plant resistant species. If areas of the stand are of poor quality and vigor or harbor off-site trees, she could establish small openings during harvest operations and plant desirable species following site preparation. She could also retain the larger California black oaks with heart rot and other large defective trees for wildlife habitat.

Appendix A

Photo: Dave Shaw, © Oregon State University

References

Appendix A: References

Key Books

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Hagle, S., K. Gibson, and S. Tunnock. 2003. *Field Guide to Diseases and Insect Pests of Northern and Central Rocky Mountain Conifers*. USDA Forest Service, Northern and Intermountain Region. R1-03-08.

Shaw, D.C., P.T. Oester, and G.M. Filip. 2009. *Managing Insects and Diseases of Oregon Conifers*. EM 8980. Corvallis, OR: Oregon State University Extension Service. https://catalog.extension.oregonstate.edu/em8980

Wood, D.L., T.W. Koerber, R.F. Scharpf, and A.J. Storer. 2003. *Pests of the Native California Conifers*. California Natural History Guide Series No. 70. University of California Press.

Websites

U.S. Forest Service, Forest Insect and Disease Leaflets

http://www.fs.fed.us/r6/nr/fid/wo-fidls/fidls-insects.shtml

Oregon Department of Forestry, Forest Health and Forest Pest Notes

http://www.oregon.gov/ODF/ForestBenefits/Pages/ForestHealth.aspx

Oregon State University Forestry and Natural Resources Extension

http://extensionweb.forestry.oregonstate.edu/

Oregon Forest Resources Institute Learning Library

http://oregonforests.org/content/ofri-resources?t=76

Pacific Northwest Plant Disease Management Handbook

http://pnwhandbooks.org/plantdisease/

Pacific Northwest Insect Management Handbook

http://insect.pnwhandbooks.org/

Pacific Northwest Nursery Integrated Pest Management

http://oregonstate.edu/dept/nurspest/

Appendix B

Photo: Lauren Grand, © Oregon State University

For the educator

Pest Scene Investigator, an OSU Forestry & Natural Resources Extension Program

Insects and Disease in your Forest

Diagnosis and Management for Forest Health

Photo by Nicole Strong, (c) Oregon State University

DAY
DATE
9 a.m.–3 p.m.

OSU Extension Office
_____
_____

FREE
RSVP: XXX-XXX-XXXX

Join us for a day of learning how to better understand forest health issues in your forest. We will practice identifying various local insects, disease, and environmental issues, and discuss management options based on your unique goals. Please bring a lunch and dress for a day out in the woods. These skills can also be applied to your Master Woodland Manager service.

Details: http://extension.oregonstate.edu/deptname

Oregon State University

This is an editable PDF file. Extract this page from your curriculum and open it in Adobe Acrobat Pro. Using the edit text and images tool, add the address, day and date, and RSVP phone number to create a flyer to advertise the training.

Pest Scene Investigator Training: Sample Agenda

Adjust fields in italics

Time	Location	Activities	Speaker/Instructor
9 a.m.	Site 1	Welcome and Introduction ■ Overview of day ■ Introduction to PSI objectives ■ Distribute books, hand lenses, and handouts ■ Review steps in diagnosing tree damage and mortality, include signs, symptoms, context, patterns ■ Using the Diagnosis of Tree Problems form and book resources	*Host agent and/or lead instructor*
9:30 a.m.	Site 1	First field exercise ■ Landowner describes situation ■ Instructor leads group through diagnosis form ■ Explore site with tools ■ Instructor leads discussion on management options	*Host agent and/or lead instructor and landowner*
10:30 a.m.		Break and transition to Site 2	
11 a.m.	Site 2	Second field exercise ■ Landowner describes situation ■ Instructor starts group off with diagnosis ■ Students determine final diagnosis and recommendations in small groups ■ Regroup to discuss diagnosis and management options	*Host agent and/or lead instructor and landowner*
12 p.m.	Site 2	Lunch ■ Break into groups to do Case Study Exercise over lunch ■ Discuss Case Study Exercise answers (15–20 min)	*Host agent and/or lead instructor*
1 p.m.		Break and transition to Site 3	
1:30 p.m.	Site 3	Third field exercise ■ Break into groups and go through diagnosis form and management options without instructor ■ Regroup to go over group answers	*Host agent and/or lead instructor and landowner*
2:30 p.m.		Closing discussion ■ Review common clientele issues in host county ■ Lifelong learning (what to do from here; handout) ■ PSI Service Ideas (handout)	*Host agent and/or lead instructor and participants*
3 or 3:30 p.m.		Break and transition back to Site 1	
3:30 or 4 p.m.	Site 1	Class ends ■ Dismiss participants	*Host agent and/or lead instructor*

Pest Scene Investigator Tour

Roseburg and surrounding area

Do you wonder what might be damaging or killing trees on your property?

Would you like to know best practices for dealing with diseased trees?

Do you want to learn more about managing for a resilient, healthy forest?

If so, this will be a great opportunity to learn about a wide variety of insects and diseases common to your local forests. Join OSU Extension Forest Health specialists and Pest Scene Investigator volunteers for a day out in the woods, learning how to diagnose and manage insect and disease problems, including bark beetles, foliage-damaging insects and diseases, root rots, tip-damaging insects, rusts, vertebrate wildlife, and more.

Photo by Nicole Strong, © Oregon State University

DAY
DATE
8:45 a.m.-
2 p.m.

OSU Extension Office

_____

_____

FREE
RSVP: XXX-XXX-XXXX

Be prepared for walking outside, rain or shine. Drinks will be provided, but please bring a sack lunch.

Details: http://extension.oregonstate.edu/deptname

Oregon State University

This is an editable PDF file. Extract this page from your curriculum and open it in Adobe Acrobat Pro. Using the edit text and images tool, add the address, day and date, and RSVP phone number to create a flyer to advertise the tour..

Evaluation and recommendations–PSI training

1. Are you currently a Master Woodland Manager? _____yes _____no
2. If so, how long have you served as a MWM? _____ years

3. Please rate your motivations to come to Pest Scene Investigator, with 1 being the "Least motivator", and 5 being the "Biggest motivator"

	Least motivator				Biggest motivator
Learn new forest health information	1	2	3	4	5
Connect with other MWMs	1	2	3	4	5
Learn from OSU faculty	1	2	3	4	5
Improve my diagnosis skills	1	2	3	4	5
Tour local forestlands	1	2	3	4	5
Become a more skilled volunteer	1	2	3	4	5
Other					

4. Please rate your confidence level after participating in the PSI training, with 1 being "Not at all confident" and 5 being "Very confident."

	Not at all confident				Very confident
ON YOUR OWN PROPERTY					
Diagnosing forest health issues	1	2	3	4	5
Developing management recommendations	1	2	3	4	5
ON SOMEONE ELSE'S PROPERTY					
Diagnosing forest health issues	1	2	3	4	5
Developing management recommendations	1	2	3	4	5

5. Please rate on a scale of 1–5 how much you feel you know after attending the PSI training, where 1 is "Know Very Little" and 5 is "Know a lot."

	Know very little				Know a lot
Assessing forest health issues	1	2	3	4	5
How to access forest health resource professionals	1	2	3	4	5
Context of damage	1	2	3	4	5
Diagnosing insect problems	1	2	3	4	5
Diagnosing disease problems	1	2	3	4	5
Making management decisions in context of forest health	1	2	3	4	5
Resources for continued learning after the PSI class	1	2	3	4	5
Who to contact with further questions	1	2	3	4	5
How to apply this to my MWM volunteer service	1	2	3	4	5

6. What did you find **MOST USEFUL** about PSI?

_____

_____

7. What would you like to see **IMPROVED** for the next PSI?

_____

_____

8. How do you think you will apply PSI to your own forest management?

_____

_____

9. How do you think you will apply PSI to your MWM volunteer service?

_____

_____

10. After participating in the PSI training, what additional training do you feel you need before you can help someone diagnose a forest health problem? Check all that apply.

____ Use of *Field Guide to Common Diseases and Insect Pests of Oregon and Washington Conifers*

____ Use of *Managing Insects and Diseases of Oregon Conifers*

____ More diagnosis experience in the field

____ More sample collection experience in the field

____ More experience with making management recommendations

____ Other_____

11. How many acres of land do you own? _____forest acres _____agriculture acres

If you have any other comments regarding PSI, please write them here:

THANK YOU!