Forest Pathology and Entomology: Diagnosis, Assessment, and Management



(e.g.... How to Determine the Cause of Tree Damage, Whether it is Important, and What to Do About It)

Linda Haugen, Plant Pathologist USDA FS, Forest Health Protection St. Paul, Minnesota

Outline

• Steps in diagnosis • What part of the plant is affected? • Determining when a situation needs intervention •Tools for intervention: Management strategies • Common problems: Case Studies

Outline



Steps in Diagnosis

- 1. Identify the host and determine if plant growth is normal
- 2. Collect site information
- 3. Collect host information
- 4. Consult references and make a diagnosis
- 5. Submit plant samples for laboratory analysis





Steps in Diagnosis

1. Identify the host and determine if plant growth is normal



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Steps in Diagnosis 1. Identify the host and determine if plant growth is normal

2. Collect site information

site conditions

U.S. Drought Monitor Midwest



October 2, 2012 (Released Thursday, Oct. 4, 2012) Valid 7 a.m. EST

Drought Conditions (Percent Area)							
Non	e D0-D	4 D1-D4	4 D2-D4	D3-D4	D4		
Current 9.48	90.52	2 69.86	39.43	15.92	0.28		
Last Week 9/25/2012 8.75	91.25	5 67.48	41.58	14.88	0.28		
3 Month s Ago 7/3/2012 25.5	5 74.45	52.56	24.76	5.60	0.00		
Start of Calendar Year 1/3/2012 71.8	4 28.16	5 13.47	6.80	0.00	0.00		
Start of Water Year 8.75 9/25/2012	91.25	5 67.48	41.58	14.88	0.28		
One Year Ago 10.4/2011 57.0	8 42.92	2 16.33	6.12	0.00	0.00		

Intensity:

D0 Abnormally Dry

D1 Moderate Drought D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

D3 Extreme Drought

Author: Anthony Artusa NOAA/NWS/NCEP/CPC





Image from http://soils.usda.gov/survey/how_to/



Steps in Diagnosis 1. Identify the host and determine if plant growth is normal

2. Collect site information



http://woodlandsteward.squarespace.com/storage/past-issues/global.htm

http://woodlandstewardship.org/?page_id=703

Photo © Mel Baughman



Steps in Diagnosis 1. Identify the host and determine if plant growth is normal

2. Collect site information

site conditions

patterns on site



Patterns of Symptom Distribution on site	Possible Causal Agents
Groups of plants in low areas.	Abiotic: frost and winter injury, flooding and pesticide concentrationBiotic: diseases favored by high humidity and soil moisture
Groups of plants in high areas.	Abiotic: nutrient deficiencies, drought and wind injury Biotic: secondary insect and disease pests that attack weakened and predisposed trees
Most of trees near the edge of a stand or planting.	 Abiotic: Management activities that create stand edge effects, and induce stress associated with increased soil temperatures, reduced soil moisture levels, and increased wind damage. Biotic: movement of insect or disease pests from nearby tree species or windbreaks.
Groups of plants under the canopy of older trees.	Biotic: diseases and insect pests that move from the infested overstory trees to the understory trees and are favored by high humidity, shade, or feed on smaller diameter shoots.
Groups of plants along roadways.	Abiotic: de-icing salts or herbicides applied for weed control.



(patterns on site...)



Along fields

In "pockets"





(patterns on site...)



Beside roadways



Susan K. Hagle, USDA Forest Service, Bugwood.org







Steps in Diagnosis

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patterns on host

plant part affected



Patterns of Symptom Distribution

Top-down; Outside in

This pattern is typical of damage caused by agents that disrupt the absorption and translocation of water and nutrients from the roots to the foliage.

Bottom-up; Inside-out

This pattern is typical of biotic agents that require high humidity, leaf surface water, or physical protection from desiccation, wind and rain.

One-sided.

This pattern is typical of damage caused by agents that affect one side of the tree.

All over

This pattern is typical of abiotic agents and some very fast moving biotic agents.





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Patterns of Symptom Distribution	Possible Causal Agents
Top-down; Outside in This pattern is typical of damage caused by agents that disrupt the absorption and translocation of water and nutrients from the roots to the foliage.	 Abiotic: improper planting techniques, drought and mechanical injury to roots, stems or main branches. Diseases: vascular wilt, canker and root diseases. Insects: root feeding, wood boring and some leaf feeding insects.
Bottom-up; Inside-out This pattern is typical of biotic agents that require high humidity, leaf surface water, or physical protection from desiccation, wind and rain.	Diseases: leafspot and needle cast diseases.
One-sided. This pattern is typical of damage caused by agents that affect one side of the tree.	Abiotic: de-icing salt or herbicides applied to roadways, mechanical injury to roots.Diseases: diseases that colonize one portion of the root system or the main stem.
All over This pattern is typical of abiotic agents and some very fast moving biotic agents.	 Abiotic: episodic weather events such as frost, winter injury, lightning strikes, high winds, hail or ice storms, drought, chemical injury and air pollution. Diseases: a small number of diseases that invade the conducting tissues can kill trees within a few weeks. Insects: insects that rapidly colonize and destroy the phloem and outer xylem such as bark beetles.

Outline

• Steps in diagnosis • What part of the plant is affected? • Determining when a situation needs intervention •Tools for intervention: Management strategies • Common problems: Case Studies • Current Research



The PATTERN of symptom development is often influenced by the plant part affected.

not all diseases are created equal... the plant part affected can greatly affect the seriousness of the disease impacts.

- Disease examples
- Insect feeding guilds

- Roots and Root
 Collar
- Main Stem and Major Branches
- Vascular System
- Shoots/Twigs/Buds
- Foliage



Insect feeding guilds and how they affect plant parts

- Roots and Root
 Collar
- Main Stem and Major Branches
- Vascular System
- Shoots/Twigs/Buds
- Foliage

- Root feeders
- Bark beetles and wood-borers
- Shoot and twig
- Galling insects
- Sucking
- Defoliators
- Seed and cone

Helpful overview:

http://www.myminnesotawoods.umn.edu/2007/04/forest-health-insects/

Roots and Root Collar

- •May show up as a general decline or dieback in the crown or as whole tree death.
- •May also be visible as wilting, dwarfed leaves or other leaf symptoms throughout the entire crown.
- •Damage to root strength may be visible as wind thrown trees.
- •If you suspect that the root system is damaged, dig down and look at the roots.



Roots and Root Collar



Linda Haugen, USDA Forest Service, Bugwood.org





Roots and Root Collar



Pine root collar weevil *Hylobius radicis* (www.bugwood.org)

Main Stem and Major Branches

- •Prevents water and nutrients flow within the crown of the tree, so the damage may be first demonstrated as crown symptoms, such as dieback, wilting, chlorosis (yellowing) or death of foliage.
- •Sometimes the damage is readily evident on the stem other times it is "hidden" below the bark.
- •On hardwoods with stem injury, there may be sprouting from the stem below the point of injury.



Roots and Root
 Collar

Main Stem and Major Branches



Linda Haugen, USDA Forest Service, Bugwood.org



• Main Stem and Major Branches

Bark beetles



"Frass" from pine engravers (*Ips* spp.) (www.bugwood.org)



• Main Stem and Major Branches

wood-borers



Pine sawyer (*Monochamus* spp.) (Nebraska Forest Service)



Vascular System

•Pathogens that systemically infect conducting tissues (xylem and phloem) within the vascular system of trees impair the transport of food, water and nutrients between the roots and foliage.

•Vascular infections within trees are often fatal and can be caused by fungi, bacteria, phytoplasmas and nematodes.



- Roots and Root Collar
- Main Stem and Major Br
- Vascular System





Shoots/Twigs/Buds

•Can be distinguished from main stem and branch injury because the branch tissue is alive, but the shoot or twig is killed.

•Use a knife to cut into the bark and look for the margin between the live and dead shoot tissue.



- Roots and Root Collar
- Main Stem and Major Brar
- Vascular system
- Shoots/Twigs/Buds





•Shoots/Twigs/Buds

Shoot feeders

Red pine shoot moth Dioryctria resinosella (USFS)



Foliage

•Leaves indicate general tree health and trunk and/or root problems, as well as problems affecting the leaves directly. Is the problem localized on the leaves? •Problems that remain localized on the leaves, (e.g. leafspots or insect defoliation) are usually not lethal. •Repeated defoliation weakens trees and predisposes them to insect borers, canker fungi or winter injury. Defoliation along with drought or other stress can contribute to dieback and decline.



- Roots and Root Collar
- Main Stem and Maior Branches
- Vascular s
- Shoots/Tv
- Foliage





• Foliage

Defoliators

Jack pine budworm Choristoneura pinus pinus (UMN Extension)





• Foliage

Sucking

Introduced basswood thrips *Thrips calcaratus* (USFS)





• Foliage Galling insects



Cooley spruce gall adelgid Adelges cooleyi Wikipedia



Key things to keep in mind

- Impacts vary across part of plant affected by types of disease and insect feeding guilds
- 2. Focus on host, life cycle, expected impacts, and appropriate management
- 3. Management to one pest may predispose problems to another



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- **3. Collect host information**
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Consult references and make a diagnosis

USDA FOREST SERVICE		Fore	st Service National Links 🛩 Go	
	Northeastern Area			
Search Northeastern Area Home Conservation Education Fire & Aviation Management Forest Health Protection Forest Stewardship Publications Sustainability and Planning Urban & Community Forestry Watershed Programs Wood Education & Resource Center Financial Assistance to Partners Reports and Achievements	Northeastern Area Publications and Productions Northeastern Area offers an extensive collection of General Technical Report Please search our online databases for publications that interest you. Search for Publications Select Area for Searching: Ourtheastern Area All Records in Treesearch Search for this: Search > Or try our Advanced Search	<section-header><section-header><image/><image/><section-header><section-header></section-header></section-header></section-header></section-header>	that you may download.	UBS DITION
For information about publications contact, Patty Dougherty (610)557-4225		Post Alers These publications are one-page facts restrict boot new or unusual tree perty. They are intended to alers	γ	

http://www.na.fs.fed.us/pubs/

Submit plant samples for laboratory analysis

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Figuring out when a situation needs intervention

- Is this serious/lethal?
- Will it spread/increase?
- Is there anything you can do about it?



Outline



Integrated Pest Management According to the EPA:

 IPM is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. It uses current, comprehensive information on the life cycles of pests and their interaction with the environment. Available pest control methods are used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.

Guidelines for success in IPM

- Have clear management goals/ know thresholds of damage.
- Monitor / Survey (repetitive, multiple levels of scale); Identify culprits.
- Prevent problems by keeping things healthy.
- ► Use available tools when necessary.

Insects and diseases are GREAT at finding stressed trees. Anything to increase host vigor is a good start!

IPM Strategies: What's in the Toolbox? (not a comprehensive list)

- Proper selection of tree species
- Cultural control/ Silviculture
- Exclusion/Prevention (Quarantines)
- Eradication (e.g. of alternate hosts)
- Resistance breeding
- Biocontrol
- Semiochemicals
- Chemical control

Species selection/site selection/provenance

Cultural control (e.g., site preparation, vegetation control, thinning, avoiding mechanical wounds, reducing insect and/or disease inoculum loads, eliminating refugia, etc.)

> Red pine thinning St. Louis County UMN Extension



Eradication (esp. of alternate hosts)

Red pine killed in sea of sweet fern from Saratoga spittlebug(USFS, Steve Katovich)



Exclusion (e.g., TCD, EAB and Gypsy Moth quarantines)

Host Resistance- WPBR, DED, Chestnut Blight, etc.

Biological control (and microbial control): using predators, pathogens, and parasites to reduce pest populations



Aerial spraying of "Bt" (*Bacillus thuringiensis*) against gypsy moth (USFS)



Friendly flies, parasites on forest tent caterpillars (MN DNR)

Semiochemicals

- Host volatiles
- Aggregation pheromones
- Anti-aggregation pheromones
- Sex pheromones



(http://semiochemical.com) Disparlure pheromone flakes against gypsy moth (aerial application) (Iowa DNR)



Chemicals

- Contact vs. systemic
- Often used in targeted control operations





White pine aphid (University of Kentucky)

Ash injection for emerald ash borer (www.slameab.info)

Points to remember when creating management plans

- Insects and diseases are natural* parts of forests. Your forest will experience growth loss due to pests
- If you understand biotic and abiotic conditions that foster insects and diseases (i.e., hazard ratings), you can mitigate their effects to some extent*

*invasive species not included

Outline



Common Lake States Problems

- Oak
- Jack/Red/White Pine
- White Spruce/Balsam fir
- Northern Hardwoods
- Aspen/Birch
- Black ash/Tamarack/Black Spruce



Common Lake States Problems

Case Studies

Diagnosis: Consider Host, timing and patterns on site, patterns on host

Assessment: Is it serious? Will it spread? What can you do?



Oak type



Oak issues

Oak wilt disease Oak decline/Two-Lined Chestnut Borer/Armillaria Anthracnose Galls Bur Oak Blight



Case 1: Oak – oak wilt

Diagnosis

- Host
- Timing and Patterns on site



Case 1: Oak – oak wilt



<u>Diagnosis</u>

- Patterns on Host,
- Plant part affected





Case 1: Oak – oak wilt

Assessment How Serious? Will it spread? What can you do?



Case 2: oak – oak anthracnose

<u>Diagnosis</u>

- Host
- Timing andPatterns on sitePatterns on Host,Plant part affected





Joseph O'Brien, USDA Forest Service, Bugwood.org

<u>Assessment</u> How Serious? Will it spread? What can you do?



Jack/Red/White Pine

Jack Pine Budworm **Heterobasidion Root Disease** Pine engravers White pine blister rust White pine weevil/ Northern pine weevil **Shoot blights** Armillaria root disease



Case 3: Pine-- HRD

What to look for on site: 1) Pockets of progressive pine mortality. 2) Stumps with conks near the soil line. 3) Dying/dead white pine in openings (white pine is particularly sensitive to HRD and Armillaria).



Diagnosis - Host - Timing and Patterns on site - Patterns on Host, Plant part affected





Case 3: Pine-- HRD



4) Decaying stumps or butt logs with a white stringy rot. 5) Small "popcorn conks" on the base of recently killed trees or even on roots, usually below the duff. You may also note resin soaking in affected roots and stems. You can have both HRD and Armillaria on the same site, or even on the same tree.



Case 3: Pine-- HRD

2014 Guidelines for Prevention of Heterobasidion Root Disease (HRD) of Pines on NFS Region 9 National Forests Prepared by SPFO and DFO FHP pathologists, with input from others; April 2014

Introduction

In 2010, the St. Paul Field Office (SPFO) Forest Health Protection (FHP) staff prepared guidelines for the LAKE STATES National Forests. We now have new information and broader interest in the potential impacts of Heterobasidion Root Disease (HRD). These guidelines are intended to replace the 2010 guidelines, and expand the scope to address National Forests of the entire Eastern Region.

Background on Heterohasidion Root Disease

In this section, we provide background information that is foundational to our management recommendations. In many cases, we cite synopsis or overview documents (rather than original scientific papers), as they are more generally available to the land manager. However, for some specific pieces of information we cite some more obscure sources.

Location/Distribution

Mycology collections and field observations from the mid-1900s include conks of "Fames, annasus" from multiple locations in the northeastern US. Molecular tools have allowed differentiation of European and American species, and we now recognize that in North America we have two species of Heteropasidion: H. accidentais (formerly referred to as H. anno sum s-type), which is most common on spruce and fir in the western states, and H. irregulage (formerly referred to as H anno sum p-type), that is most common on pines in the eastern and western states (Otrasina and Garbellotto 2010). The name Heterophysicilian approxime in the strictest sense is now used to refer to a Eurasian species that is not present in North America. Only H. insequare is known to be present in eastern North America, and therefore historical references to Fames annous from the eastern United States and Canada likely refer to H irregulare. H. annorum and H irregulare are now considered sister species, and have a high degree of mating compatibility. Dalman (2010) suggested in his doctoral thesis that the ancestor

of the present day H. irregulare migrated to North America across a trans-Atlantic land bridge some 30 to 60 million years ago. Linzer et al. (2008) had suggested that an ancestral fungus entered North America from Asia across the Beringian land bridge, retreated to Mexico during glaciation, and gave rise to H. irregulate that subsequently migrated back north with conifer species. Regardless of origin, in their current geographic ranges, Heterobasidion species have developed differences in ecological behavior. Therefore, one cannot assume that management recommendations that have been developed for the Eurasian H. anno sum will fully apply to H. irregulare in North America



Assessment How Serious? Will it spread? What can you do?

Summary of HRD Treatment Recommendations for R9 National Forests



potentially adjust window.



Case 4: Pine– Shoot Blights





<u>Assessment</u> How Serious? Will it spread? What can you do? <u>Diagnosis</u> - Host - Timing and Patterns on site - Patterns on Host, Plant part affected



Black Ash/Tamarack/Black Spruce

Anthracnose Emerald Ash Borer Larch Casebearer Larch Beetle Larch Sawfly



Lowland conifer & hardwood -- Anthracnose







Lowland conifer & hardwood -- EAB







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