Extension Note

BC Journal of Ecosystems and Management

British Columbia's Coastal Forests

Laminated Root Rot Forest Health Stand Establishment Decision Aid

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Introduction

Laminated root rot (*Phellinus weirii*) is the most prominent root disease of Douglas-fir in coastal coniferous forests and is endemic throughout its host's range in British Columbia. The disease spreads primarily via root contact and can attack and gradually kill trees throughout their life cycle. It can lower stand volume by 40–70% on infected sites and acts as a stand-altering disturbance agent. The retention of infected stumps and residual trees (via partial cutting) can perpetuate the incidence of laminated root rot in a regenerating stand by leaving material on site to act as reservoirs of disease. To mitigate disease impact, a good understanding of the distribution and biology of *P. weirii* is necessary. The cedar form of *P. weirii*, which is responsible for a butt rot in western redcedar, is not covered in this extension note.

The Stand Establishment Decision Aid (SEDA) format has been used to extend information on various vegetation and forest health concerns in British Columbia. This decision aid summarizes information that relates current management regimes to the spread and effects of laminated root rot. The first page provides general information, hazard ratings for some of the biogeoclimatic zones and subzones of the Coast Forest Region, and silvicultural considerations for laminated root rot. The second page outlines the growth and yield implications and other effects and associations of the disease. This page also includes a valuable resource and reference list to provide readers with more detailed information. Reference material that is not available on-line can be ordered through libraries or the Queen's Printer at: *http://www.qp.gov.bc.ca*

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KEYWORDS: *forest health, forest management, laminated root rot,* Phellinus weirii*, root disease management.*

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Laminated Root Rot–British Columbia's Coastal Forests

Canadian Forest Service, Pacific Forestry Centre

Uprooted coastal Douglas-fir with the characteristic root wad caused by laminated root rot.

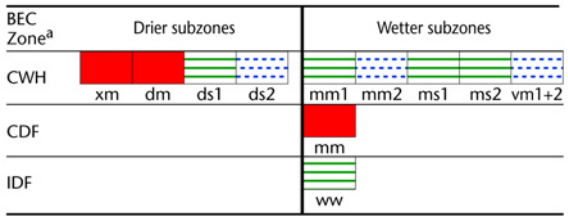
Characteristics of Susceptible Stands

- Managed stands of highly susceptible species (e.g., Douglas-fir).
- Preceding stands infected.

General Information

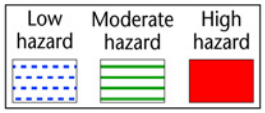
- Although taxonomists agree that the Douglas-fir and cedar forms of *P. weirii* are actually two closely related species, the correct names for them have not yet been agreed upon. The species on Douglas-fir is proposed to be called *P. sulphurascens*; the species on western redcedar, *P. weirii*.
- Laminated root rot is often first detected during ground reconnaissance surveys when canopy openings and standing dead and fallen trees are observed.
- When an infected tree falls over, decayed major roots often break off close to the root collar creating a compact root ball or "root wad."
- Disease centres within mature Douglas-fir stands range from a few trees to several hectares. Several factors will determine whether disease distribution is aggregated or dispersed.
- Resistant hardwoods or conifers (e.g., western redcedar) often fill in openings created when Douglas-fir infected with laminated root rot die.
- Small groups of symptomatic and dead trees usually become evident in plantations after 10–20 years.
- Crown symptoms of laminated root rot include reduced height growth, discoloration and loss of needles, and stress-induced cone crops; however, other damaging agents or an environmental condition may cause similar symptoms. Close examination of roots is recommended.

Hazard Rating[1]



[a] See Meidinger and Pojar (1991) for an explanation of Biogeoclimatic Ecosystem Classification (BEC) zone, subzone, and variant abbreviations.

Hazard Rating Key



[1] Hazard ratings are for Douglas-fir and grand fir and are based on field observations only.

- Grey-white, tawny, or purplish ectotrophic mycelia (ECM) form on at least a portion of infected roots. When looking for ECM, carefully remove soil beginning at the root collar and then continue outward along lateral roots.
- Evidence of ECM may not be found with limited excavation.
- A protective, crusty layer of dark brown hyphae is often formed over ECM near the root collar.
- Wood with advanced decay displays small oval pits and easily separates along annual rings (delamination). Often associated with this are masses of brown setal hyphae that may form in pits or in any cracks or openings in affected tissues. Setal hyphae are diagnostic of *Phellinus weirii*.
- Reddish brown stained wood, often visible on fresh stump tops, is also a good indicator of the disease. In direct sunlight, the stain may fade after just a few weeks.
- Fruiting bodies of laminated root rot can form on the underside of fallen trees and uprooted stumps, but are too rare or inconspicuous to be useful for disease detection or assessment/survey.
- The disease spreads through root contact between adjacent infected trees or stumps and susceptible hosts.
- After the onset of crown symptoms, larger trees live an average of 10 years.
- When infected trees die, the pathogen continues to live saprophytically. In large, infested stumps and large roots, it may do so for 50 or more years. As such, any infected stump or tree should be considered a potential source of inoculum, although this risk will decline over time.

Host Information

- **Highly Susceptible:** Douglas-fir, grand fir, amabilis fir, and mountain hemlock
- **Moderately Susceptible:** Western hemlock, subalpine fir, Sitka spruce, and Engelmann spruce
- **Tolerant:** Western white pine and lodgepole pine
- **Resistant or Immune:** Western redcedar, yellow-cedar, and broadleaf species

Harvest Considerations

- Before developing a harvest plan, assess the presence of root disease.
- If a visual assessment indicates more than 5% occurrence of root disease, conduct a formal survey to determine its distribution and severity.
- Disease distribution is important; aggregated, clearly defined infection centres (including a buffer) may be stratified for treatment while adjacent areas are left untreated. A high incidence, or widely dispersed distribution, may render some management strategies unworkable.
- Treatment strategies are usually based on either inoculum reduction (e.g., removal of stumps) or the selection of other, less-susceptible species for regeneration.
- The most cost-effective time to mechanically reduce inoculum is at harvest when personnel and machinery are already on-site.
- The effects of alternative silvicultural systems (e.g., variable retention) on root disease dynamics are not well quantified.

Silviculture Considerations

Regeneration/Establishment

SITE PREPARATION

- Consider inoculum reduction, through stump and root removal, only on gently sloping, high-quality sites with amenable soils where machinery can work without risk of degrading soils. Only stumps of susceptible species need be removed.
- Push-falling of Douglas-fir up to 78 cm DBH is an alternative method for reducing inoculum. Like stump removal, it is best suited to high-quality Douglas-fir or grand fir sites with slopes of less than 30% and sandy to sandy loam soil textures.

PLANTING

- When inoculum removal is not an option, consider species that are immune or have lower susceptibility. This may mean planting less productive species for a rotation on an infected site.
- Susceptible species planted or growing naturally near an infected stump may be colonized and killed within a few years.

Silviculture Considerations (continued)

Regeneration/Establishment

PLANTING

- An inoculum avoidance strategy, through altering stocking density, is generally ineffective. Avoiding the planting of susceptible species near infected stumps is only effective if such stumps can be reliably identified beforehand.
- To improve stocking levels, use tolerant or immune species when fill-planting in areas with scattered dead and dying trees.

Plantation Maintenance

- If mortality from root disease is high and widely distributed in sapling stands, consider rehabilitating the plantation by starting over after an inoculum reduction treatment or by replanting with resistant species. This kind of rehabilitation is a method of last resort.
- When spacing or thinning infected stands, retain immune and lower-susceptibility species to increase barriers to root disease spread.
- When thinning a stand where the disease is clearly aggregated, remove susceptible trees in disease centres and an adjacent buffer (from 5 to 15 m depending on stand age) to reduce spread of the fungus.
- Unless an inoculum removal treatment was applied, do not reduce stocking below target levels if more than 60% of the trees are moderately or highly susceptible.
- Unless disease distribution is clearly aggregated, avoid commercial thinning when laminated root rot is dispersed through 15% or more of the stand. This is due to the possibility that asymptomatic infected trees will be retained as crop trees; such trees may soon be windthrown.
- Fertilization does not appear to have any effect on the spread of laminated root rot or on the mortality it causes.

Potential Productivity Implications

- Laminated root rot can reduce productivity and harvestable yield of managed stands by 40–70% through mortality, growth reduction, and butt rot. Infected trees are susceptible to windthrow and insect damage.
- Annual wood volume losses to laminated root rot in British Columbia are estimated at 1.4 million m^3.
- For timber supply purposes, an additional operational adjustment factor (OAF) is added to the default OAF2 value for all Douglas-fir-leading types greater than 10 years old in the CDFmm and CWHxm1 and xm2 subzones. This value is currently 7.5% and represents losses to all root diseases. To account for better root disease management practices, a discounted value (not lower than the default OAF2 value of 5%) may be applied to Douglas-fir types 10 or less years of age.
- Salvage logging may be conducted on declining and recently killed trees to recover economic value. Salvage logging will neither reduce nor enhance the incidence of *P. weirii* in a logged stand.

Other Effects and Associations

- *Phellinus weirii* is a disturbance agent that creates ecosystem and stand structural diversity, coarse woody debris, and wildlife habitat. It creates canopy gaps that provide growing space for less susceptible conifers and immune hardwoods and shrubs.
- The removal of Douglas-fir overstorey by laminated root rot can affect plant community diversity and ecological succession.
- Limited research has been conducted on *P. weirii* and its interactions with other organisms.
- Laminated root rot can co-occur in stands and on individual trees with other root diseases (e.g., Armillaria root rot and blackstain root disease).

Resource and Reference List

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Test Your Knowledge . . .

British Columbia's coastal forests: Laminated root rot Forest Health Stand Establishment Decision Aid

How well can you recall some of the main messages in the preceding Extension Note? Test your knowledge by answering the following questions. Answers are at the bottom of the page.

1. Crown symptoms in conifers, such as reduced height growth and stress-induced cone crops, can be caused by several damaging agents including laminated root rot. Which of the following signs and symptoms on affected roots are *not* indicative of laminated root rot?
   A) Reddish brown stained wood
   B) Grey-white, tawny, or purplish ectotrophic mycelia
   C) Creamy white mycelial fans under the bark
   D) Masses of brown setal hyphae in pitted, decayed wood

2. Before harvest, a formal root disease survey should be conducted in stands affected by laminated root rot if a visual assessment indicates the following occurrence of the disease:
   A) > 2.5%
   B) < 5%
   C) > 5%

ANSWERS

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