Extension Note

BC Journal of Ecosystems and Management

British Columbia's Forests

White Pine Blister Rust Forest Health Stand Establishment Decision Aid

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Introduction

White pine blister rust (*Cronartium ribicola*) is an introduced disease affecting five-needle pines throughout North America. Like other non-native pests, its impact on the native hosts has been dramatic, decimating species such as western white pine in both number and distribution. Because of its prevalence, white pines have been removed from commercial forestry consideration in most areas. This is unfortunate as western white pine is an excellent substitute for Douglas-fir in areas prone to laminated root disease. It can also command a premium price. To mitigate disease impact and permit management, a good understanding of the biology of *C. ribicola* is necessary.

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 white pine blister rust. The first page provides general information, hazard ratings for the biogeoclimatic zones and subzones of British Columbia, and biological considerations for white pine blister rust. The second page outlines the implications to silviculture and the various techniques used to manage the disease. This page also includes a resource and reference list to provide readers with more detailed information. Reference material that is not available online can be ordered through libraries or the Queen's Printer at: *www.qp.gov.bc.ca*

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White Pine Blister Rust

Norm Alexander

Infected western white pine displaying streaming pitch from a canker and multiple branch flagging.

General information

- White pine blister rust (WPBR) is caused by *Cronartium ribicola*, a non-native fungus that is an obligate parasite and requires a live host to survive and reproduce.
- First reported in 1854 on eastern white pine (*P. strobus*) planted in Estonia, WPBR spread across Europe in about 40 years. It likely originated in Asia, although an exact location is not known.
- Introduced on eastern white pine seedlings into western North America (Vancouver, BC) and possibly other locations before 1915, WPBR appeared earlier (1906) in eastern North America, also via shipments of seedlings from Europe.
- Because of the effect of WPBR on eastern white pines, the *Plant Quarantine Act* was passed in 1912; Quarantine Number 1 prohibited the importation of 5-needle pines to the United States and Canada.
- The western North American distribution ranges from British Columbia in the north (on whitebark pine) to South Dakota in the east (on limber pine), and to New Mexico (on southwestern pine) and California (on sugar pine) in the south. The disease has not yet been reported in Mexico. Western white pine is affected throughout all of its range.

Host information

Highly Susceptible: Western white pine (*Pinus monticola*), whitebark pine (*P. albicaulis*), limber pine (*P. flexilis*), and all other five-needle pines native to North America.

Immune: Non-five-needle pines and other trees.

Hazard rating

- Hazard rating is high throughout British Columbia (based on Pine Stem Rust Management Guidebook).
- Biogeoclimatic zone has no known effect on hazard rating. Hazard rating declines at elevations above 1000 m on the Coast. The steeper the slope, the higher cankers are found in the crowns, particularly on trees not selected for resistance. On such sites, consider early harvesting.

Susceptible stand characteristics

- Stands containing highly susceptible pine species (e.g., wild western white pine).
- Presence of *Ribes* species (the alternate host) in proximity (within 30 m) to susceptible species greatly increases the hazard of infection.
- In northern Idaho, some *Pedicularis* (lousewort) and *Castilleja* (paintbrush) species are confirmed alternate hosts. The impact of these hosts on the disease needs further evaluation.

Signs and symptoms

- **Symptoms:** swelling of infected tissues forming fusiform cankers often with streaming pitch, roughened bark on old (often dead) cankers, and necrotic foliage on cankered branches (so-called "red flagging").
- **Signs:** pyncial droplets forming around canker margins, orangish bark, orange aeciospores in ruptured blisters in spring, and uredial and telial structures on foliage of the alternate host.
- Diamond-shaped stem cankers expand annually, growing faster vertically than horizontally. Death occurs when secondary organisms (other fungi and insects) invade cankers, often through aecial ruptures.
- Cankers within 30 cm of stem can spread mycelia into the stem; those more than 60 cm away never infect the stem.

Life cycle

- *Cronartium ribicola* is a heteroecious, macrocyclic rust that requires two hosts and has five spore stages: pycnial and aecial on *Pinus*, and uredinial, telial, and basidial on the alternate host (see Figure 1).
- Given proper moisture and temperature conditions, infection on the pine host commences with the transfer of basidiospores to foliage and subsequent germination. The fungus enters through stomata and begins to colonize leaf tissue, often creating distinct yellow to red infection spots or bands.
- Successful infections eventually grow into the branch (or stem if infected needle is directly attached) beginning a latent period in which fungal development continues with no evident outward symptoms.
- Infected tissues swell to create a visible canker from which blisters containing orange aeciospores appear. Wind-dispersed in spring, these spores are relatively durable, travelling several kilometres to colonize an alternate host. Often, the infected needle remains attached to the canker long after other foliage has died.
- Aecia invade the leaves of the alternate host (again through the stomata); pustules form shortly after releasing short-lived urediospores that spread to adjacent foliage and intensify the disease over the summer.
- From these pustules, telia develop as hairlike columns which remain in place on the leaf underside.
- Each teliospore germinates, producing four, wind-dispersed basidiospores that travel back to a pine host, completing the asexual cycle in the late summer/fall. Life-cycle timing is delayed at higher elevations.
- Sexual reproduction occurs by transfer of pycniospores (spermatia) exuded as a sticky mass at the canker margin often a year before aecia development. Flies attracted to exudate act as vectors.

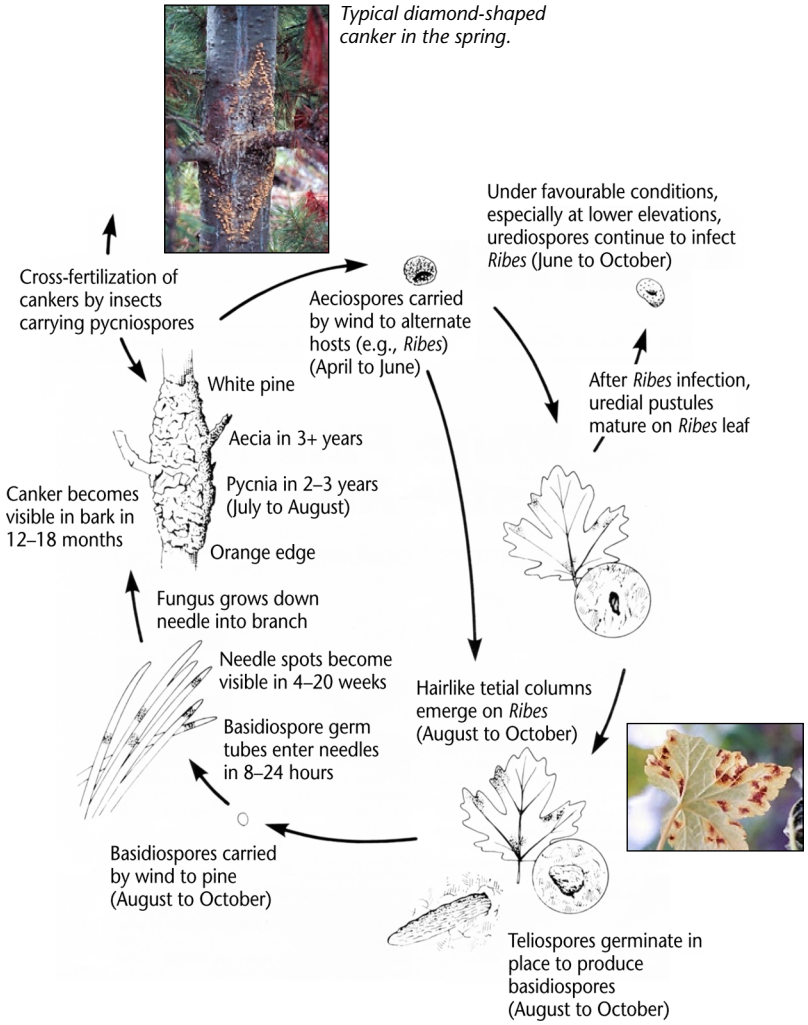

FIGURE 1. *Life cycle of white pine blister rust (Source: Canadian Forest Service; Richard Hunt photo, top).*

Disease management

For managing rust-susceptible white pine stands, the following actions are recommended to meet stocking standards.

Harvesting and site preparation

- Harvesting practices greatly affect the ability of *Ribes* spp. to regenerate. Winter logging reduces ground disturbance and provides a less inviting seedbed. Low volume removals retain canopy thus maintaining low light levels, which reduces seed germination.
- Although the use of fire for site preparation was previously advocated to reduce seedbanking, this method's effectiveness is quite inconsistent; partial disturbance may increase *Ribes* seed germination.
- If possible, threatened whitebark and limber pines should not be cut during harvesting operations to retain the genetic diversity of these species.

Alternate host eradication

- Up to the 1970s, the Americans conducted a massive *Ribes* eradication program that largely failed in the West due to the extreme difficulty of eliminating them. However, local eradication can be very effective.
- In some areas, currants are a popular crop, but their cultivation may increase the local rust hazard. Generally, black currants (*Ribes nigrum*) are very susceptible to WPBR, while red currants are less so. Rust-resistant, commercial black currant cultivars frequently show poor yields and a susceptibility to powdery mildew. Several resistant, ornamental currants are available.

Regeneration/establishment

GENETIC RESISTANCE

- In British Columbia, resistant western white pines have been sought for 25 years. Resistant selections: (1) have slowly growing small cankers (possibly conferred by "polygenes"); or (2) have developmental disease resistance (conferred by age and elevation); or (3) are "totally clean" (conferred by a single dominant, or major, gene).
- Seed orchards are composed of the first two types; coastal orchards have coastal selections and interior orchards have interior and Idaho selections. Resistant seed is available.
- Pollen from major gene resistant (Cr2) trees identified in the Cascade Range is used in coastal seed orchards to produce 50–100% "clean" seedlings that still retain superior growth characteristics. This seed should be used for coastal reforestation. Above 1000 m, use resistant stock from an interior or Idaho orchard. In the Interior, use only material from British Columbia or Idaho orchards (65% or better canker-free).

SEEDLING PROTECTORS

- Enclosed seedling protectors, which physically block spores from susceptible foliage during the early growing years, show promise. Tests continue.

Stand tending

CANKER EXCISING

- As canker excision is time consuming, it should be restricted to high-value trees in parks or highly visible locations. Remove the live bark and cambial tissue surrounding the margin of a stem canker at least 5 cm past the leading side edge and 20 cm past the top and bottom edge of those that have not spread more than halfway around the stem. Moistening bark will help to define the canker boundary.

THINNING AND PRUNING STANDS

- Thinning non-resistant pine protects uninfected trees and culls infected ones. However, thinning without pruning increases WPBR infections because as thinning increases, airflow and spore circulation increases. Retain about 700 stems per hectare.
- Lower branch pruning reduces the incidence of WPBR. Over 85% of infections occur in the first 2 m; therefore, early removal of susceptible foliage reduces the number of fatal infections. Pruning should not be required when regenerating with resistant stock.
- Currently, a two-lift system is recommended. Conduct the first pruning when average stand height reaches 1–2 m, removing up to 50% (Interior) or 65% (Coast) of the live crown (leave at least three live whorls). Conduct the second pruning when trees reach 4–5 m, removing at least 50% of the live crown. To ensure wood quality in the first log, an optional third lift is possible.
- Consider autumn pruning to lessen tree damage due to bark stripping. Trimmed boughs are a non-timber forest product providing revenue if sold as ornamental floral greens. Ensure that pickers do not leave long branch stubs.
- Free-growing damage criteria state that trees with stem or branch infections less than 60 cm from the bole are unacceptable.

BIOLOGICAL CONTROL

- Other fungi will parasitize cankers and compete with WPBR. Purple mould (*Tuberculina maxima*) is associated with declining or inactive cankers; however, neither this nor other fungi have been used successfully as a biological control.

FUNGICIDES

- Although several chemicals offer prophylactic protection or kill established cankers, most provide limited or ineffective protection. However, triadimefon (not registered in Canada) provides some protection to nursery stock and seedlings when applied during planting.

Other effects and associations

- Mountain pine beetle may prefer trees with stem cankers; old basal cankers may contain decay.
- Resin-producing basal stem cankers might be confused with symptoms of Armillaria root disease.

Resource and reference list

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Test Your Knowledge . . .

British Columbia's Forests: White Pine Blister Rust 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. From what seed sources should resistant seedlings be grown?

2. Which silviculture treatments are most effective for protecting white pine?

3. How does white pine blister rust differ from pine stem rusts on lodgepole or ponderosa pines?

Answers

1. For coastal stock, seedlings that originated from nurseries using major gene resistant (Cr2) seed sources should be used. Several coastal orchards have this type of seed available. For interior stock, seedlings that have parentage from Idaho sources should be used. Seed for these trees is available from the Bailey Seed Orchard near Vernon.

2. Select resistant stock for planting. Thin out infected trees or remove the alternate hosts to reduce local rust levels. Prune to reduce the risk of infection or to remove infected branches. Excise cankers to protect valuable individual trees.

3. Stem rusts of hard pines, such as comandra and stalactiform blister rusts, are also from the genus Cronartium*. Although the hosts differ, the life cycles are identical to WPBR. Western gall rust, however, is a hard pine stem rust that transfers directly between pines without requiring an alternate host.*