Western Spruce Budworm Identification and Impacts to Silviculture Surveys

Choristoneura freemani

Host Species:
- Primarily Douglas-fir
- Occasionally spruce, true firs and larch

Identification:

Egg:
- Laid in late July-August
- Laid overlapping like scales on the underside of needles
- Bright green when fresh, but turn white after hatching (approx. 12 days

Larvae (Caterpillars):
- Overwinter in the upper canopy, then descend when new buds open to begin feeding
- Feeding begins in late May and continues through late June – early July
- Larvae prefers new growth, but will feed on older growth and developing cones
- White spots along length of larvae is diagnostic compared to other caterpillars

Pupae:
- Present from late June – mid July, found within webbed needles
- 1 – 1.5 cm long, red-brown in colour

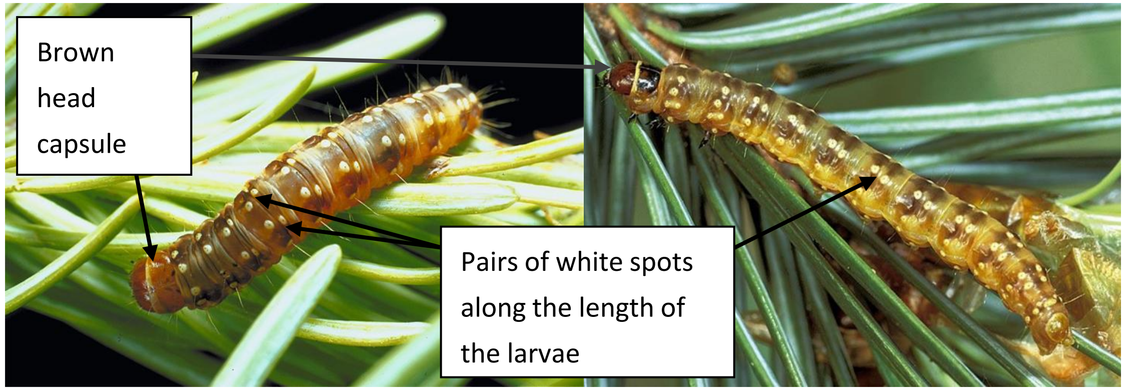
Adults:
- Appear mid-July to early August, only persist for 2 weeks to breed and lay eggs
- Adults are a grey or light brown with darker brown or red mottling

Indicators:
- Crowns of damaged trees appear reddish-brown from June – September
- Initial defoliation notable in tree tops and branch tips
- Feeding waste accumulates in webbing of burst buds where feeding occurs

Similar Damaging Agents:
- Damage can be confused with other defoliators such as Tussock moth or cone worms
- Distinguish from other budworm species based on host species and distribution

Dion Manastyrski, Natural Resources Canada, Canadian Forest Service

Survey Implications:
- Damage code: IDW
- Review current Silviculture Survey Procedures Manual regarding defoliation
- It is best practice to re-survey following a heavy defoliation year to determine whether it was a one-year event



Warren's Root Collar Weevil Identification and Impacts to Silviculture Surveys

Hylobius warreni

Host Species:

- Primarily lodgepole pine
- Spruce
- Trees >2cm at root collar

Identification:

- Larvae are large, up to 2 cm, creamy-white with orange-brown heads
- Adults are flightless weevils with distinctive curved snout, 1.0 – 1.5 cm long with dull black-flecked colouring and gray-white scales


Therese Arcand, Natural Resources Canada, Canadian Forest Service

Survey Implications:

- Damage code: IWW
- Live crown vigour depleted
- Girdling or stem damage

Indicators:

- Young trees can be girdled at the root collar, causing mortality
- Older trees can be partly girdled, but tend not to die, but exhibit growth loss and increased susceptibility to root rots
- Weevil populations increase as duff layer deepens and on moister sites
- Infested plantations contain scattered, random mortality with some clumps
- Damaged trees exhibit chlorosis from light yellow to red
- Damaged trees are typically easy to push over or pull out, may have a lean
- Resin is mixed in with the soil at the base of infested trees

Similar Damaging Agents:

- Similar damage at base of trees to small mammal damage such as voles and rabbits
- Chlorosis can be initially confused with root rots or rusts
- Indicator damage includes small tube-like shelters as well as resin mixed with soil at the base of damaged trees


Photo Credit: Avonlee Paterson


Photo Credit: Avonlee Paterson

Lodgepole Pine Terminal Weevil Identification and Impacts to Silviculture Surveys

Pissodes terminalis

Host Species:

- Lodgepole pine, usually from 1.5 – 10.0 m in height

Identification:

- Larvae are legless, stout grubs with yellowish bodies and brown head, up to 1.2 cm in length in final instar
- Adults are mottled red-brown weevils with a long, curved snout, 0.4 – 1.0 cm in length

Weevil larva mining in leader
British Columbia Ministry of Forests, www.gov.bc.ca

Indicators:

- First symptoms of attack emerge in late spring-early summer in the form of small holes in the base of the current year's leader with resin droplets
- By mid-summer, the current year's leader turns chlorotic, turning from yellow, to red, and finally brown
- By late summer-fall, large exit holes appear in in the middle of current year's leader
- Historic attack is comprised of deformed or multiple leaders and dead stubs along the main stem. Dead stubs break easily and are filled with coarse woody particles and pupal chambers

Similar Damaging Agents:

- Other terminal feeders, frost and other abiotic damage and canker disease can cause leader death
- Look for larvae in the feeding season (summer-fall) and for the pupal chambers and debris in previously-attacked leaders

Survey Implications:

- Damage code: IWP
- Prefers open-growing, vigorous trees
- Older damage includes forked tops and multiple leaders
- Review current FS660 for forking damage that is acceptable/non-acceptable

Lodgepole pine terminal weevil leader damage
Jerald E. Dewey, USDA Forest Service, Bugwood.org

White Pine Weevil Identification and Impacts to Silviculture Surveys

Pissodes strobis

Host Species:
- Spruce (despite its name)
- Will occasionally attack pine
- Prefers trees 1.5 – 10.0 m in height

Identification:
- Larvae are legless, stout grubs with yellowish bodies and light brown head, up to 1.0 cm in length in final instar
- Adults are mottled red-brown to black with cream markings with a long, curved snout, 0.5 – 0.8 cm in length
- Eyltra (wing covers) are heavily scaled and mottled in appearance

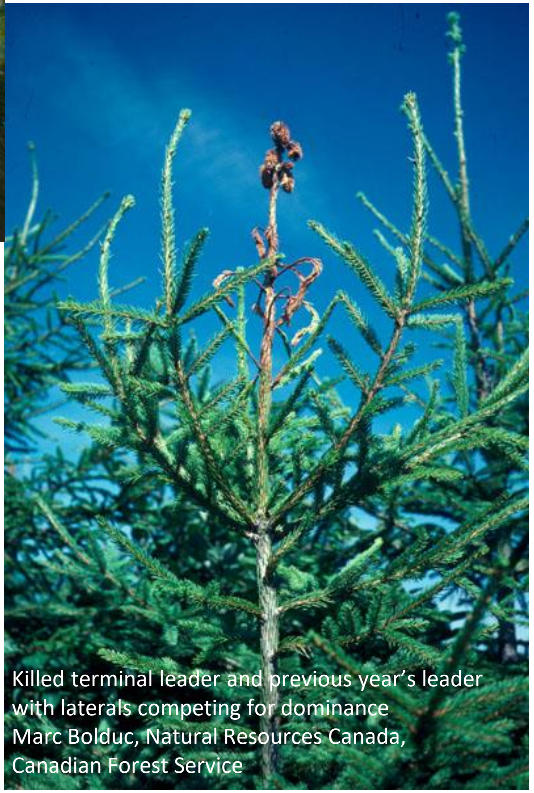
Indicators:
- First symptoms of attack emerge in late spring-early summer in the form of small holes in the base of the current year’s leader with resin droplets
- By mid-summer, the current year’s leader takes on a wilted appearance and changes from yellow to red to brown
- Drooping, wilted appearance results in “shepherd’s crooks”
- Larvae feed together down the leader and create diagnostic “chip cocoons” where they pupate
- By late summer-fall, large exit holes appear in in the middle of current year’s leader. The current year’s and previous year’s leader are usually dead by this time
- Dead stubs are brittle and contain the distinctive “chip cocoons”
- Repeated attack will stunt tree growth and result in and may allow undesirable species to overtake spruce in a planted stand

Similar Damaging Agents:
- Other birds, frost and other abiotic damage
- Look for larvae in the feeding season (summer-fall) and for “chip cocoons” in older damage

Survey Implications:
- Damage code: IWS
- Prefers open-growing, vigorous trees
- Older damage includes forked tops and multiple leaders

Larvae feeding in leader. Note the fine dust that will form “chip cocoons
Therese Arcand, Natural Resources Canada, Canadian Forest Service

Adult Weevil
Therese Arcand, Natural Resources Canada, Canadian Forest Service



Killed terminal leader and previous year’s leader with laterals competing for dominance
Marc Bolduc, Natural Resources Canada, Canadian Forest Service

Stalactiform Blister Rust Identification and Impacts to Silviculture Surveys

Cronartium coleosporoides

Host Species:

- Lodgepole pine
- Ponderosa pine

<u>Identification:</u>

- Stem canker is usually diamond-shaped and roughly 10 times longer than it is wide
- Rodents feed on infected bark, which can produce small dark ridges along the edge of the wound
- In the absence of rodent feeding, white blisters containing orange-yellow spores along canker edge in spring or early summer
- Trees that survive infection will have flattened, elongated "cat faces" where the rust was active and may exhibit bole sweep. The damage caused by the rust may weaken the stem, making it susceptible snow or other breakage

<u>Indicators:</u>

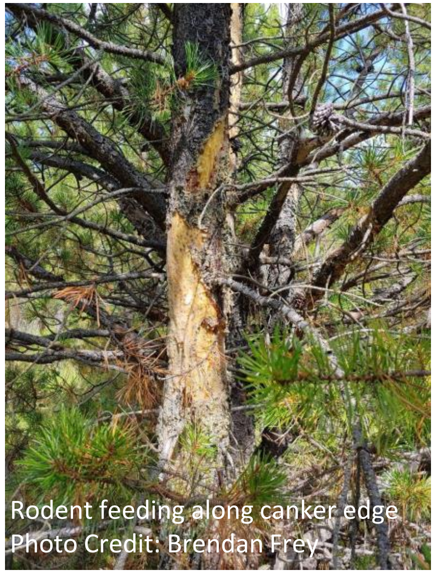
- Alternative host is Indian Paintbrush (*Castilleja* sp.)
- Can infect trees of all sizes and ages and can cause mortality on small or non-vigorous trees
- Is often fatal to the tree when on the stem of younger, smaller trees
- Crown symptoms often do not occur until just before the tree dies

<u>Similar Damaging Agents:</u>

- Atropellis canker and other pine stem rusts can appear similar to stalactiform
- Indicator damage is that stalactiform cankers are usually diamond-shaped and roughly 10 times longer than they are wide, they can be metres long in length

<u>Survey Implications:</u>

- Damage Code: DSS
- Review current Silviculture Survey Procedures manual regarding stem and branch cankers
- If the stand is suspected to contain rust, surveys should be scheduled in spring – early summer while the rust is sporulating



Rodent feeding along canker edge
Photo Credit: Brendan Frey

Note length vs width of canker face
Photo Credit: Brendan Frey

Old, healed-over "catface"
Photo Credit: Brendan Frey

Comandra Blister Rust Identification and Impacts to Silviculture Surveys

Cronartium comandrae

Host Species:
- Lodgepole pine
- Ponderosa pine

Identification:
- Mainly a disease of young lodgepole pine
- Host will not show crown symptoms until just before death
- Branch cankers are blunt swellings that girdle the branch
- Stem cankers are oval or diamond-shaped, usually less than four times the width
- Stem cankers are usually lethal to the host and often start as branch infections
- In spring, cankers release orange spores that rodents feed on, leading to exposed wood at the canker margins

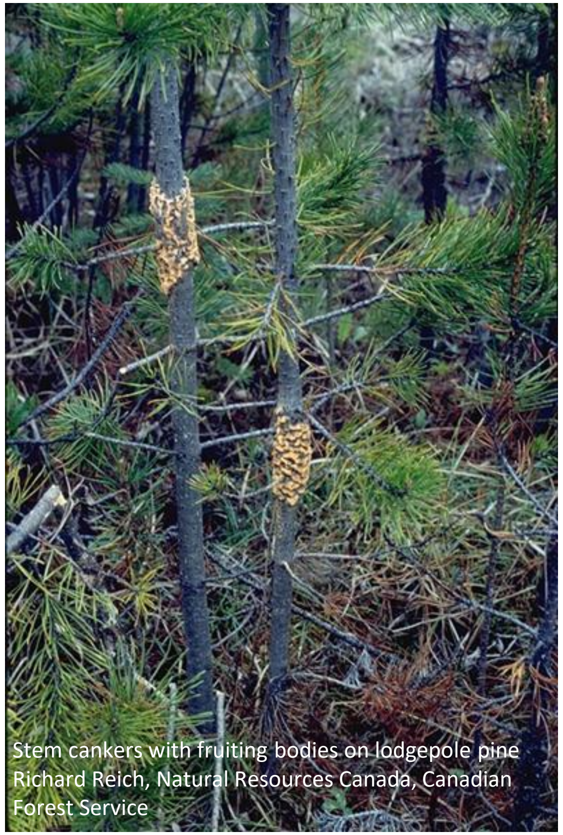
Indicators:
- Alternative host is bastard toadflax (*Comandra umbellata*)

Similar Damaging Agents:
- Stem cankers of atropellis and other pine stem rusts can appear similar to comandra
- Indicator damage for stem cankers is that comandra cankers are usually much shorter and blunt when compared to the long, narrow cankers characteristic of stalactiform blister rust
- Branch cankers can be confused with western gall rust – comandra branch swellings result from swollen bark while western gall rust swelling will have normal bark over swollen woody tissue

Survey Implications:
- Damage Code: DSC
- Review current Silviculture Survey Procedures manual regarding stem and branch cankers
- If the stand is suspected to contain rust, surveys should be scheduled in spring – early summer while the rust is sporulating


Fruiting bodies on bastard toadflax
Natural Resources Canada, Canadian Forest Service


Stem canker on lodgepole pine
Photo credit: Michelle Seager


Stem cankers with fruiting bodies on lodgepole pine
Richard Reich, Natural Resources Canada, Canadian Forest Service


Branch canker on jack pine
Natural Resources Canada, Canadian Forest Service

Western Gall Rust Identification and Impacts to Silviculture Surveys

Endocronartium harknessii

Host Species:
- Lodgepole pine
- Ponderosa pine

Survey Implications:
- Damage Code: DSG
- Review current Silviculture Survey Procedures manual regarding galls
- Galls produce orange spores in late spring-June, making identification easier

Identification:
- Disease causes easily recognized galls on branches or stems; galls are spherical or pear-shaped and swelling occurs in the woody tissue with normal bark
- Most common negative effects are reduced wood quality and reduced growth
- Vigorously-growing trees are more susceptible, and it is more common in open stands when compared to denser stands
- If a gall girdles the branch, foliage will begin to die on the branch section distal to the gall until the distal branch completely dies
- Mortality is rare, but can occur if galls form on and girdle the stem, mortality may occur. Mortality may also occur due to breakage in gall-weakened sections due to wind or snow press
- Rodents feed on the galls in the winter, which can lead to gall mortality and/or possible avenues for further infection

Indicators:
- Unique to the pine rusts, western gall rust requires no alternate host
- Western gall rust rarely causes mortality and will remain on the host so long as the host lives

Similar Damaging Agents:
- Comandra branch cankers can be confused with western gall rust – comandra branch swellings result from swollen bark while western gall rust swelling will have normal bark over swollen woody tissue

Immature gall that has yet to produce spores
Eric Allen, Natural Resources Canada, Canadian Forest Service

Stem galls on seedlings
Yasu Hiratsuka
Natural Resources Canada,
Canadian Forest Service

Heavy western gall rust infestation causing deformity
Natural Resources Canada, Canadian Forest Service

Galls on branches and stem of lodgepole pine
Eric Allen, Natural Resources Canada, Canadian Forest Service

Armillaria Root Rot Identification and Impacts to Silviculture Surveys

Armillaria ostoyae

Host Species:
- Douglas-fir
- Pines
- True firs
- Western hemlock

Identification:
- Indicators of possible Armillaria infection include chlorotic foliage, thinning crowns, reduced growth, distress cones and basal resinosis near the ground
- Can impact any age or size of tree in a stand
- Symptoms are usually shared by a cluster of trees with thinning crowns and possible dead understorey regeneration, but can also be scattered throughout a stand with only certain individuals exhibiting symptoms
- Other pests often attack trees weakened by Armillaria (bark beetles). The pest may be directly responsible for tree mortality, but they would not have been attracted to that tree had it not been for Armillaria causing the initial stress
- Advanced root rot centres are indicated by a patch of shade-tolerant conifers or deciduous trees in an otherwise shade-intolerant stand. The original site occupants (shade-intolerant) were killed by root rot and replaced by the shade-intolerant and deciduous trees.

Indicators:
- Clear the duff and mineral soil around the base of a suspect tree. Chop into the base of the stem and peel back the bark for the white mycelial fans that are indicative of Armillaria root disease
- Soft, golden-yellow mushrooms at the base of trees as well as black shoestring rhizomes trailing along the surface of infected roots

Similar Damaging Agents:
- Other root diseases
- Bark beetle infestations can "hide" Armillaria centres (see above)
- Abiotic factors such as drought, flooding, air pollution, road salt etc. all generate symptoms in trees (chlorosis, thinning crowns, stress cones etc.) similar to Armillaria

Survey Implications:
- Damage Code: DRA
- Review current Silviculture Survey Procedures manual regarding root disease
- Partial/selective harvesting can exacerbate Armillaria by creating reproductive centres at cut stumps that then spread through rhizomes and root contact to new regeneration

Armillaria mushrooms
Duncan Morrison, Natural Resources Canada, Canadian Forest Service

Chlorotic Douglas-fir sapling in root rot centre (note thin overstorey in background
Photo Credit: Ashley Dahl

White mycelial fans under bark
Photo Credit: Ashley Dahl

Elytroderma Needle Cast Identification and Impacts to Silviculture Surveys

Elytroderma deformans

Host Species:

- Lodgepole pine
- Ponderosa pine

Survey Implications:

- Damage Code: DFA
- Review current Silviculture Survey Procedures manual regarding Elytroderma needle cast and defoliation
- Severe defoliation can lead to tree mortality

Identification:

- Needles turn red the year following infection and fade to a straw colour
- Needles are cast in the fall, early fall for ponderosa pine, late fall for lodgepole pine
- Thinned crowns can result, as well as "lions' tails" – branches with no needles except for at branch tips
- Infection can be more intense on moist sites such as valley bottoms or near riparian features
- Can cause brooming since this fungus can spread from needles to shoot tissue, which is a feature unique to this needle disease

Black fruiting bodies on needles
John Hopkins, Natural Resources Canada, Canadian Forest Service

Indicators:

- Dark fungal fruiting bodies along needle surfaces
- Brooming is unique to this fungal needle cast

Similar Damaging Agents:

- Can be confused with lodgepole pine dwarf mistletoe when it causes broomlike symptoms in host; look for presence or absence of mistletoe fruiting bodies; alternatively, look for the fungal fruiting bodies on host foliage characteristic of elytroderma
- Other needle casts – look for the characteristic dark streaks of fungal fruiting bodies along the surface of infected needles and possible brooming

Crown thinning due to Elytroderma infection
Photo credit: Emma Raine

Discoloured Needles
Eric Allen, Natural Resources Canada, Canadian Forest Service

Lodgepole Pine Dwarf Mistletoe Identification and Impacts to Silviculture Surveys

Arceuthobium americanum

Host Species:
- Lodgepole pine
- Occasionally infests ponderosa pine
- Rarely infests spruce and Douglas-fir

Survey Implications:
- Damage Code: DMP
- Review current Silviculture Survey Procedures manual regarding mistletoe and the Hawksworth rating procedure

Identification:
- Infected branches are usually slightly swollen
- Aerial shoots grow from these swellings and can be 3 – 12 cm long
- Once aerial shoots disperse their seeds and fall off, ridged basal cups persist on the branch or stem
- Most conspicuous symptom is the presence of“witches' brooms” have long, slender, upright branches with sparse needles
- Brooming is more severe in open stands
- Brooming can become so heavy that branches break, leaving a wound behind that provides an avenue for further infection as well as degrading wood quality
- Trees that are infected when immature are either prematurely killed or never attain merchantable size
- Older, moderate-heavily infected trees suffer from degraded wood quality and can have potentially 15-30% less volume than uninfected or lightly-infected trees


Swollen stem and aerial shoots on a young lodgepole pine
Eric Allen, Natural Resources Canada, Canadian Forest Service


Swollen branch with aerial shoots and berries containing eggs
Eric Allen, Natural Resources Canada, Canadian Forest Service

Indicators:
- Aerial shoots and basal cups are indicative of this parasite
- Aerial shoots are arranged in a whorled pattern with several shoots emerging at each node (basal cup) which distinguishes it from other dwarf mistletoe species

Similar Damaging Agents:
- Witches' brooms can be confused with elytroderma needle cast and older trees can form brooms for various reasons – look for the presence of aerial shoots, basal cups and swollen branches


Witches' brooms on immature lodgepole pine
Bob Erickson, Natural Resources Canada, Canadian Forest Service

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