

LESSON OVERVIEW

FOREST HEALTH

Learning Outcomes

- Students will learn about factors that affect the health of a renewable resource - a forest.
- Students will gain an understanding of a tree's defence mechanisms against diseases and pests.

Question

- What types of factors affect the health of a forest? (living and non-living?)
- How can we tell if a tree is unhealthy?

Setting the stage (approx. lesson time: 1+ hr)

- Part I: Brainstorm & Cluster** – (allow 10 min.) Have the students brainstorm factors (living and non-living) that affect the health of a forest and discuss how you can tell if a forest is unhealthy.
- Part II: Lesson** – (allow 50 min.) Go through the overheads and information on tree diseases and pests. Have the students fill out the forest health worksheet as you go along. Refer to the teacher background information for more details on each disease and pest.

Materials Needed

- Lesson Overview and Lesson Plan
- Chalkboard, or overhead
- Overheads:
 - #1 – Tree Disease Chart
 - #2 – Needle Blights
 - #3 – Wood Decay
 - #4 – Mistletoe
 - #5 – Root Rot
 - #6 – Insect Biology
 - #7 – Defoliating Insects
 - #8 – Gall Adelgids
 - #9 – Bark Beetle Chart
 - #10 – Weevils
 - #11 – Wood Borers
- Gallery and blue stain samples (from Mountain Pine Beetle Teacher Resource Package)
- Worksheets:
 - #1 – Forest health worksheet
 - #2 – Create your own forest pest
- Forest Health Glossary Sheet
- Teacher Background Information (TB)

LESSON PLAN

FOREST HEALTH

Procedure

Part I: Brainstorm and Cluster (as a class – allow 10 min.)

- Review:** the forest health glossary prior to the lesson or as you go along.
- Mention:** just as humans get sick so do forests.
- Brainstorm: living (biotic) and non-living (abiotic) factors that affect the health of a forest.** Record their answers on the chalkboard or overhead.
- Discuss: some signs that a tree is unhealthy.** (Possible answers: change in leaf/needle colour, broken branches, mushrooms around the base of the tree, sap running down the trunk, fungus growths on the branches/trunk, etc)

Part II: Lesson (as a class – allow 40+ min.)

- ⇒ **Have the students fill in Worksheet #1 (Forest Health) as you go through each section.**
- ⇒ **For more details on each living factor refer to the Teacher Background [TB] section that is noted.**

1. Non-Living (Abiotic) Factors

- Discuss:** how non-living (abiotic) factors affect the health of a forest.
 - Prolonged periods of hot and dry weather conditions – lack of water causes stress to the tree decreasing its ability to defend itself from disease and insect attack. Extreme drought conditions can cause trees to die.
 - Windstorms – High velocities of wind can uproot trees, causing them to die. It also breaks branches allowing diseases to enter the tree.
 - Fire – Forest fires often kill many trees, however they allow new healthier forests to regenerate. Fire can destroy insects and disease, therefore increasing the overall health of the forest. (Some cones need fire to release their seeds.)

2. Living (Biotic) Factors

a) Tree Diseases

- Mention:** living (biotic) factors that affect the health of the forest are either a disease or an insect and they attack different parts of the tree.
- Show overhead #1 (Tree Disease Chart):** discuss one column at a time.
- Show overhead #2 (Foliar Disease – see TB#1)**
- Show overhead #3 (Wood Decay – TB#2)**
- Show overhead #4 (Mistletoe – TB#3)**
- Show overhead #5 (Root Disease – TB#4)**

b) General Insect Biology

- Talk:** more living factors that affect the health of a forest are insects.
- Show overhead #6 (Insect Biology):** Discuss the biology and the 2 types of life cycles of an insect. (Complete/incomplete metamorphosis)

c) Defoliating Insects

- Discuss: What type of insect would affect the foliage of a tree?**
Mention that some insects are called defoliators (they defoliate/eat the needles and leaves of trees).
- Discuss: How do you think defoliating insects affect the health of the tree?** Remind the students that the foliage is where photosynthesis occurs and without foliage the tree cannot make sugars to feed the tree. This can stress the tree and make it susceptible to attacks from other pests.
- Show overhead #7 (Defoliating Insects): [TB#5]**

d) Gall Adelgids [a-del-jid] (Aphid-like Insects)

- Mention:** there are other insects that affect the foliage of the tree. They are called gall adelgids (aphid-like insects).
- Show overhead #8 (Gall Adelgids): [TB#6]**

e) Bark Beetles

- Discuss: What type of insect would attack the inner bark of the tree?**
Mention how bark beetles are some of the most damaging forest pests.
- Discuss:** the general biology of bark beetles. **[TB#7]**
- Show overhead #9 (Bark Beetle Chart)**

f) Weevils (snout beetles)

- Mention:** there are other beetles that affect the health of trees.
- Show overhead #10 (Weevils): [TB#8]**

g) Wood Borers

- Show overhead #11 (Wood Borers): [TB#9]**

Closure (allow 10+ min.)

- Mountain Pine Beetle DVD (from Market Outreach – BC's Mountain Pine Beetle Intermediate Resource Package).
- Journal Entry - have students write 3 new interesting things that they learned from the lesson.

Extensions

- Worksheet #2 (Create your own Forest Pest) – 1 per student or get students to do the assignment on poster paper.
- Guest Speaker from MOF
- Mountain Pine Beetle Lesson (from Market Outreach – BC's Mountain Pine Beetle Intermediate Resource Package)
- General Forest Health Lesson (from www.learnforestry.com)
- Force of Fire Binder

Teacher Background Information [TB]

1. Foliar Disease:

a) Brown Felt Blight

- ⇒ Attacks the foliage of the tree.
- ⇒ Symptoms that the tree is infected: Discolouring of needles, thinning of the foliage.
- ⇒ Signs of the disease: Dark masses of mycelium on the branches.

b) Douglas Fir Needle Blight

- ⇒ Attacks the foliage of the tree.
- ⇒ Symptoms that the tree is infected: Discolouring of needles, thinning of the foliage, dark spots on the needles.
- ⇒ Signs of the disease: Black fruiting bodies on the needles.

2. Wood Decay:

a) Brown Crumbly Rot

- ⇒ Attacks the tree wood.
- ⇒ Symptoms that the tree is infected: Brittle cube-like wood structure.
- ⇒ Signs of the disease: Staining of the wood, conks on the stem.

b) White Laminated Rot

- ⇒ Attack the tree wood.
- ⇒ Symptoms that the tree is infected: Pitted wood structure.
- ⇒ Signs of the disease: Yellow discolouration of the wood.

3. Mistletoe:

a) Douglas Fir Dwarf Mistletoe

- ⇒ Attacks branches and stems.
- ⇒ Symptoms that the tree is infected: Reduction in tree growth.
- ⇒ Signs of the disease: Large broom-like (clumping) structures forming on the branches of the crown.

4. Root Disease:

a) Armillaria Root Rot

- ⇒ Attacks the root system.
- ⇒ Symptoms that the tree is infected: Discolouring of needles, thinning of the foliage, reduction in tree growth.
- ⇒ Signs of the disease: Whitish fan-like fungal mycelia between the bark and wood and mushrooms at the base of the tree.

b) Laminated Root Rot

- ⇒ Attacks the root system.
- ⇒ Symptoms that the tree is infected: Discolouring of needles, thinning of the foliage, reduction in tree growth.
- ⇒ Signs of the disease: Pitted wood structure, red-brown stains on fresh stumps or on cross sections of major roots.

5.

Defoliating Insects

a) Tussock Moth

- ⇒ This insect attacks Douglas fir
- ⇒ The larvae are responsible for defoliating the foliage
- ⇒ The female adult does not have wings; she emits a pheromone, which attracts the male to her.
- ⇒ The female lays her eggs on the cocoon that she hatched from.

b) Tent Caterpillar

- ⇒ These insects attack many deciduous trees (alder, ash, birch, cottonwood, willow, and many fruit trees).
- ⇒ The larvae are responsible for defoliating the foliage.
- ⇒ They got their name from the silk tent like nests they make in the tree.

6. Gall Adelgids (Aphid-like Insects)

- ⇒ The Cooley spruce gall adelgid alternates between two trees: Douglas fir and spruce.
- ⇒ It causes cone-like galls or swellings on the branches of spruce trees but does not cause damage to Douglas fir trees.
- ⇒ Light infestations are common, yet not seriously damaging.
- ⇒ Small trees stressed by environmental conditions are often more heavily infested.

7. Bark Beetles

- ⇒ Galleries – every year female bark beetles fly to a new large, mature tree and bore into the bark of the tree and start making galleries (tunnels) under the bark (this prevents the flow of nutrients and water to the crown of the tree resulting in mortality). They then lay eggs in galleries. (**show gallery sample**)
- ⇒ Pheromone – the female beetle emits a pheromone to attract more beetles to the tree to overcome the tree's defence mechanism (the more beetles the better the chance of overcoming the tree's defence mechanism) and to attract a mate.
- ⇒ Pitch tubes – the tree's only defence mechanism against the beetle is to pitch them out with its sap.
- ⇒ Blue Stain – the beetles introduce a fungus into the tree, which grows into the sapwood of the tree and causes it to turn a blue colour. When growing into the sapwood the fungus prevents the tree from pitching out the beetles. (**show blue stain sample**)
- ⇒ Current Epidemic – Beetle outbreaks are a *natural occurrence* in our forests, but right now the mountain pine beetle is out of balance in nature and is a big problem in BC. It is killing millions of hectares of trees every year. We will not win this battle, but we will learn from it... we need to react quickly (even if the attack is in a park), we need to understand the ecological process that mature and over mature pines are a target to these bark beetles.

8. Weevils (Snout Beetles)

- ⇒ There are 2 main species of weevils in BC:
 - Spruce Leader Weevil, *Pissodes strobi*: attack spruce
 - Lodgepole Pine Terminal Weevil, *Pissodes terminalis*: attack lodgepole pine
- ⇒ Weevils attack the terminal leader of the tree.
- ⇒ The female lays her eggs in the terminal leader.
- ⇒ The larvae mine (eat) down the terminal leader.
- ⇒ The terminal leader wilts and dies, which forces the lateral leaders to take over the vertical growth.
- ⇒ Weevils rarely kill trees but rather affect the growth of trees.
- ⇒ Defects:
 - Crease – minor defect, little or no stem curvature at the point of attack.
 - Crook – a major defect, stem curvature by at least ½ the stem diameter.
 - Fork – a major defect resulting when 2 lateral stems assuming the vertical growth of the tree.
 - Staghead – a major defect resulting from 3 or more lateral stems assuming the vertical growth of the tree.

9. Wood Borers

a) Flat headed wood borers:

- ⇒ Adults are often metallic in colour.
- ⇒ Adults are attracted to dead and dying trees.
- ⇒ They lay their eggs in bark crevices.
- ⇒ Larvae have flat heads.
- ⇒ Larvae make galleries under the bark and into the wood.
- ⇒ Larval galleries in the wood are oval and they enter the wood at an angle.
- ⇒ The holes that are made in the wood by the larvae decrease the wood value.

b) Long horned wood borers:

- ⇒ Adults have antennae that are half as long as their body or longer.
- ⇒ Adults are attracted to dead and dying trees.
- ⇒ They lay their eggs in bark crevices.
- ⇒ Larvae do not have flat heads.
- ⇒ Larvae make galleries under the bark and into the wood.
- ⇒ Larval galleries in the wood are circular and they enter the wood straight on.
- ⇒ The holes that are made in the wood by the larvae decrease the wood value.

For Additional Information on these diseases/pests and a variety of others, please visit: <http://www.pfc.cfs.nrcan.gc.ca> - click on the bookstore website, type 'pest leaflet' in 'series and volume' categories. All available leaflets will be listed.

Tree Diseases

	Foliar Disease	Wood Decay	Mistletoe	Root Disease
Location on the tree	Needles/leaves	Wood inside the main stem	Branches	Roots
Signs of the disease	The presence of spots, discolouring, shrivelling or the dropping of the foliage	The presence of conks on the main stem	Swelling of the branches and growth of mistletoe shoots, broom-like structures in the crown	Yellowing and/or thinning of the foliage, gradual reduction in annual vertical growth
Damage	Reduced growth if foliage is lost over many years.	Breaks down the components of wood tissue and absorbs the resulting nutrients	Drain nutrients and water from the tree causing a decrease in growth and making it susceptible to attack by other pests.	Kills young trees quicker than older trees, blow down due to weakened roots
Examples	- Needle blights - Needle casts	- Brown rots - White rots	- Dwarf Mistletoe species that attack Douglas fir, Larch, Lodgepole pine and Hemlock	- Armillaria root disease - Laminated root rot

Needle Blights

Brown Felt Blight - Brown felt-like masses of mycelium covering the needles and branches



Spruce



Subalpine fir

Douglas Fir Needle Blight



Dark fruiting bodies of the fungus on a Douglas fir needle.



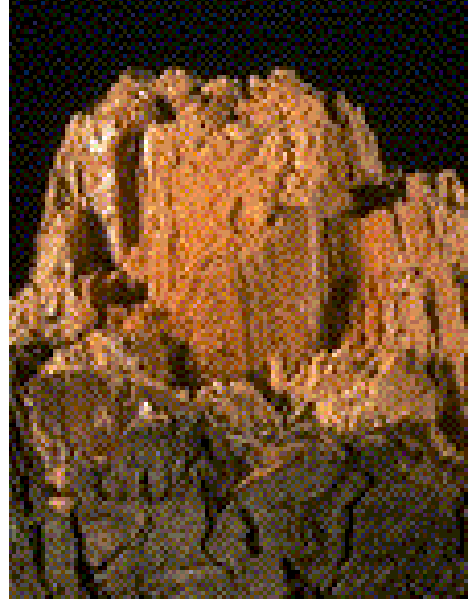
Red-brown spots on infected Douglas fir needles.

Wood Decay

Brown Crumbly Rot

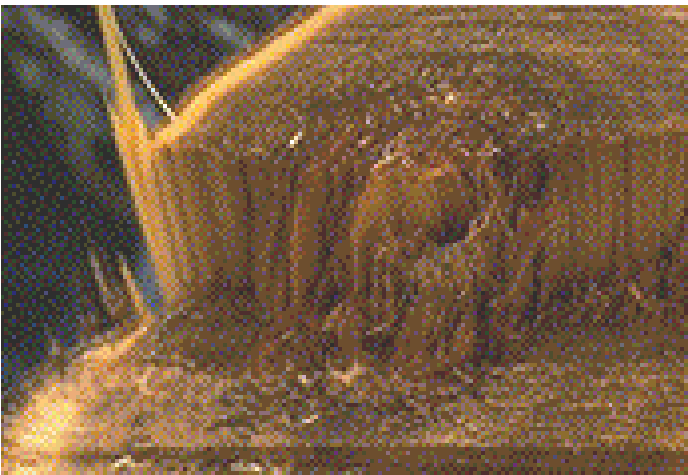


**Conk (fruiting body) of
Brown Crumbly Rot**



**Brittle cube-like
wood structure**

White Laminated Rot



**Laminate decay in western
redcedar**



**Pitted wood structure
common to many white rots**

Mistletoe

Douglas Fir Dwarf Mistletoe



Broom symptoms of Douglas fir mistletoe



Broom symptoms of Douglas fir mistletoe

Other Dwarf Mistletoes – broom symptoms



Lodgepole pine dwarf mistletoe



Larch dwarf mistletoe



Hemlock dwarf mistletoe

Root Rot

Armillaria Root Disease



**Whitish fan-like mycelia
beneath the bark of a root**



**Mushrooms (fruiting bodies) of
Armillaria growing at the base
of an infected tree**

Laminated Root Rot



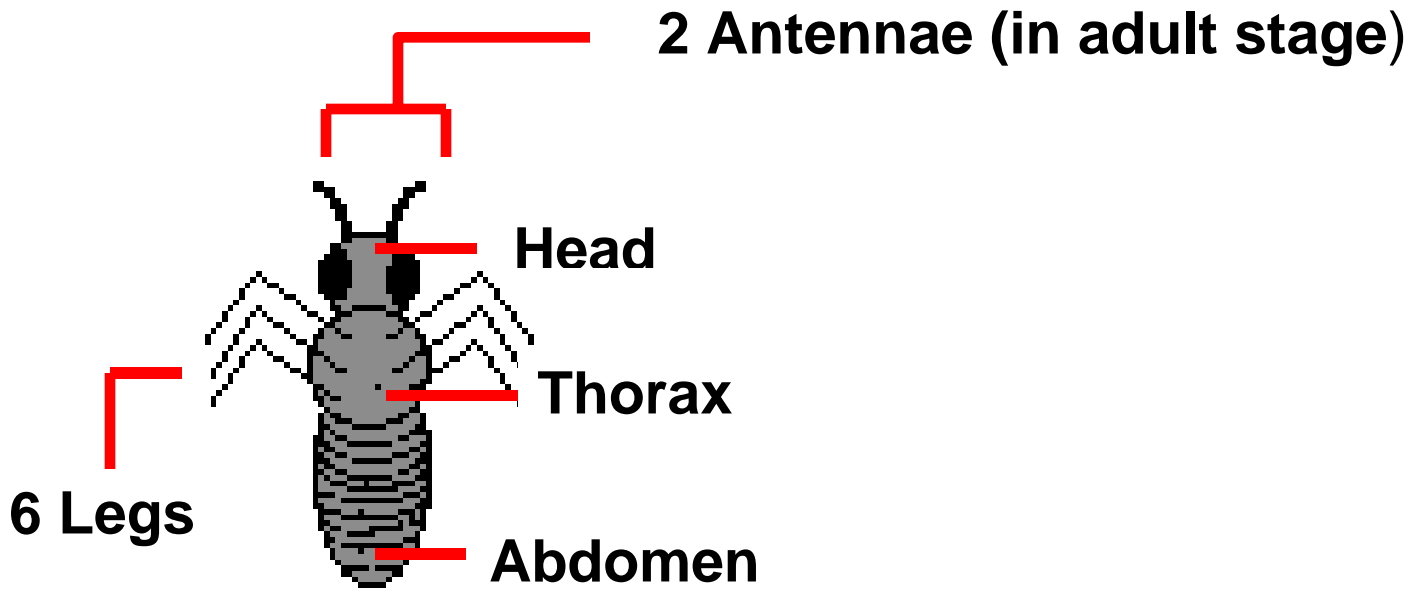
**Red-brown stains
on fresh stumps**



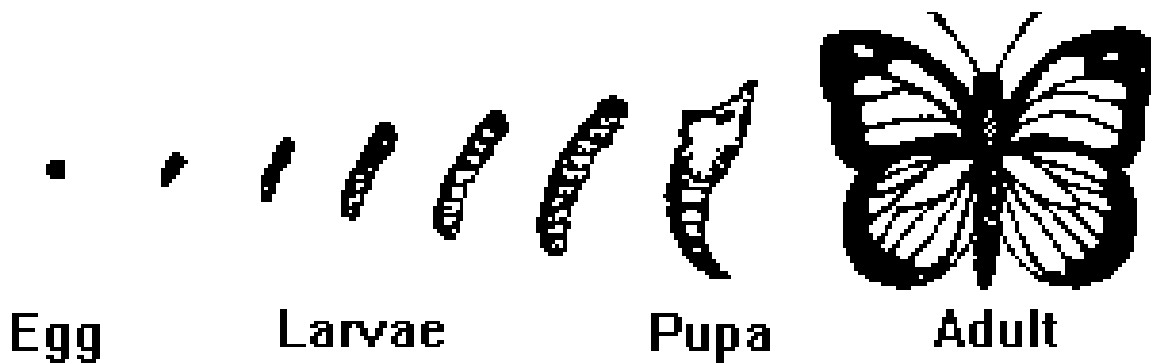
**Stem breakage on infected
Western redcedar**

INSECT BIOLOGY

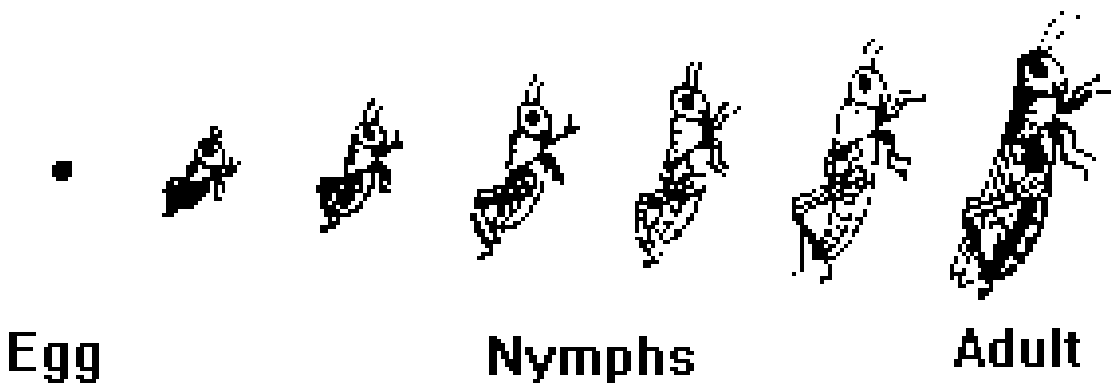
Insect Parts



Complete Metamorphosis (4 distinct stages)



Incomplete Metamorphosis



Defoliating Insects

Douglas Fir Tussock Moth



Larva



Male Adult



Female Adult

Tent Caterpillar



Larva



Adult

Gall Adelgids

Cooley Spruce Gall Adelgid



Cooley Spruce Gall Adelgids on Douglas fir



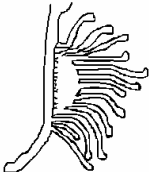
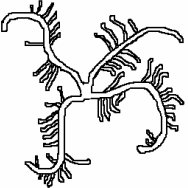






Cone-like gall on Spruce tree



Cross section of a gall showing the developing insects

Bark Beetles

Common Name	Mountain Pine Beetle	Douglas Fir Beetle	Spruce Beetle	Balsam Bark Beetle
Scientific Name	<i>Dendroctonus ponderosae</i>	<i>Dendroctonus pseudotsugae</i>	<i>Dendroctonus rufipennis</i>	<i>Dryocoetes confusus</i>
Preferred Host Species	Most pine	Douglas fir	All spruce	Subalpine fir
State of Host	Living trees only	Living trees or windfall/slash	Living trees or windfall/slash	Living/stressed or windfall
Galleries				
Adult Picture				

Weevils

Lodgepole Terminal Weevil



Adult Weevil

Photographer: Ron Long, SFU



Damage to the terminal leader of a small pine tree

Photographer: Jerald E. Dewey, USDA Forest Service

Spruce Leader Weevil



Adult Weevil



Damage to the terminal leader of a spruce tree

Wood Borers

Flat-Headed Wood Borers



Adult flat-headed wood borer



Larvae with flat heads

Long-Horned Wood Borers



Adult long-horned wood borer



Larvae with round heads

Forest Health Worksheet

1. Non-Living (Abiotic) Factors

- _____
- _____
- _____

2. Living (Biotic) Factors

a) Tree Diseases

Disease Name	Type of Disease	What Part of the Tree it Attacks	Symptoms that the Tree is Infected	Signs of the Disease
Brown felt blight	Foliar Disease			Dark masses of mycelium on the branches
Brown crumbly rot	Wood Decay		Brittle cube-like wood structure	
Douglas fir dwarf mistletoe	Mistletoe			Large broom-like structures forming on the branches of the crown
Armillaria root rot	Root Disease		<ul style="list-style-type: none"> • Discolouring of needles • Thinning of the needles • Reduction in tree growth 	

b) Defoliating Insects

Insect Name	Host Species	Interesting Fact(s)

c) Bark Beetles

Common Name				
Host Species				
Gallery Sketch				

d) Gall Adelgids - Cooley Spruce Gall Adelgid

- Host Species: _____
- Signs of Infestation: _____

e) Weevils

- 2 Main Species in BC: _____
- Location of Attack: _____
- Damage: _____

f) Wood Borers

- 2 Types: _____
- Damage: _____

Forest Health Worksheet

Answer Key

1. Non-Living (Abiotic) Factors

- Hot and dry weather conditions
- Windstorms
- Fire

2. Living (Biotic) Factors



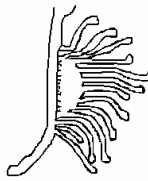
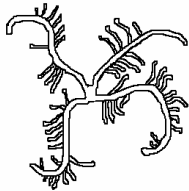
a) Tree Diseases

Disease Name	Type of Disease	What Part of the Tree it Attacks	Symptoms that the Tree is Infected	Signs of the Disease
Brown felt blight	Foliar Disease	Foliage	<ul style="list-style-type: none"> • Discolouring of needles • Thinning of the needles 	<ul style="list-style-type: none"> • Dark masses of mycelium on the branches
Brown crumbly rot	Wood Decay	Tree Wood	<ul style="list-style-type: none"> • Brittle cube-like wood structure 	<ul style="list-style-type: none"> • Staining of the wood • Conks on the stem
Douglas fir dwarf mistletoe	Mistletoe	Branches /Stems	<ul style="list-style-type: none"> • Reduction in tree growth 	<ul style="list-style-type: none"> • Large broom-like structures forming on the branches of the crown
Armillaria root rot	Root Disease	Roots	<ul style="list-style-type: none"> • Discolouring of needles • Thinning of the needles • Reduction in tree growth 	<ul style="list-style-type: none"> • Whitish fan-like fungus between the bark and wood • Mushrooms at the base of the tree

b) Defoliating Insects

Insect Name	Host Species	Interesting Fact(s)
Tussock Moth	Douglas fir	Female has no wings, emits a pheromone to attract a male: larvae eat the needles
Tent Caterpillar	Alder, ash, birch, cottonwood, willow, and many fruit trees	Larvae eat the leaves, name comes from the silk tent the larvae make

c) Bark Beetles

Common Name	Mountain Pine Beetle	Douglas Fir Beetle	Spruce Beetle	Balsam Bark Beetle
Preferred Host Species	Most pine	Douglas fir	All spruce	Subalpine fir
Gallery Sketch				

d) Gall Adelgids - Cooley Spruce Gall Adelgid

- Host Species: Alternate between Douglas fir and Spruce.
- Signs of Infestation: cone-like galls on the branches of spruce trees.

e) Weevils

- 2 Main Species in BC: Spruce Leader Weevil and Lodgepole Pine Terminal Weevil.
- Location of Attack: Terminal Leader.
- Damage: Causes deformities in the growth (Crease, Crook, Fork, Staghead).

f) Wood Borers

- 2 types: Flat headed and long horned.
- Damage: Larvae make holes in the wood, which decreases the value.

CREATE YOUR OWN FOREST PEST

Things to Include:

- Name your insect
 - Pick a type of life cycle (complete or incomplete lifecycle)
 - Draw the life cycle showing pictures of all stages
 - Draw the host tree (Include tree name)
 - Write a short paragraph telling what your insect does to the host. Be sure to include the host's defence mechanisms, and any interesting facts about your insect (ie. differences between male and female adult)
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Pest Name: _____

Life Cycle: _____

Host Tree: _____

