Mountain Pine Beetle mania

A Junior High
Science Resource

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science • issues • development • environment

Resource Authors: John Cunnian, Inside Education
Erin Gluck, Inside Education
Steve McIsaac, Inside Education

Resource Design: Kristin Manchakowski

Technical Review: Mountain Pine Beetle Strategic Direction Council
(See page 26 for contact information.)

Inside Education
www.insideeducation.ca
info@insideeducation.ca
P: 780-421-1497

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Curriculum Connections:

This resource was designed to bring the biology and issues surrounding the mountain pine beetle into the spotlight for junior high science students in Alberta. The major curriculum connections are as follows:

Alberta Grade 7 Science Unit A:
Interactions & Ecosystems

Alberta Grade 7 Science Unit B:
Plants for Food & Fibre

Alberta Grade 8 Science Unit B:
Cells & Systems

Alberta Grade 9 Science Unit A:
Biological Diversity

Alberta Grade 9 Science Unit C:
Environmental Chemistry

British Columbia students may benefit from the resource as well. Applicable science curriculum connections include:

British Columbia Grade 7 Life Science Unit:
Ecosystems

British Columbia Grade 8 Life Science Unit:
Global Ecosystems

British Columbia Grade 8 Life Science Unit:
Diversity

Key Messages:

- The mountain pine beetle is a naturally occurring insect found in pine forests in the southern Rocky Mountains and in areas west of the Continental Divide; however, it has not historically occurred in the northeastern slopes of the Rocky Mountains. An abundance of mature pine forests as a result of many years of wildfire suppression and milder winters have combined to enable the expansion of mountain pine beetle into large tracts of pine forest — prime beetle habitat.
- There are a variety of different groups concerned about managing the mountain pine beetle. All of these groups have the same goal of a healthy forest, but each group may have different ideas on the methods needed to manage the beetle that fit with their own land management objectives. These methods include: prescribed burning, cut and burn and cut and peel harvesting, development of fuel breaks, individual tree removal, thinning of highly susceptible stands and earlier harvesting of high-risk forest areas already designated for harvest.
- The Alberta government, federal government and the forest industry are working cooperatively at a regional scale to monitor and deal with mountain pine beetle infestations in Alberta in order to protect forest health, recreational opportunities, enhance wildlife habitat and reduce forest fuels.

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Mountain Pine Beetle

What is the Mountain Pine Beetle?

A Primer for Teachers & Students

If you have been following the news in British Columbia and ever-increasingly in Alberta, you may have heard of a very small (usually less than 1 cm long), yet very important insect: the **mountain pine beetle**. The mountain pine beetle (*Dendroctonus ponderosae*) is a forest insect found in the southern Rocky Mountains and in areas west of the Continental Divide; however, until recently it had not occurred in the northeastern slopes of the Rocky Mountains.

Adult mountain pine beetle

Because it is a *bark* beetle, the majority of its life cycle is spent under the outer bark of mature pine trees – in British Columbia and Alberta that mostly means lodgepole pine trees (*Pinus contorta var. latifolia*). Adult female beetles bore into the inner bark called the **phloem**. They create j-shaped vertical **galleries** into which eggs are laid. The eggs mature and develop into **larvae**. The larvae tunnel away from the egg galleries.

Mountain pine beetle larva galleries

Words appearing in bold can be found in the glossary pgs. 5-6

Usually the larvae over-winter in the tree, develop into **pupae** and in the summer emerge as adult beetles. They then exit the tree to find another pine tree **host**, and the cycle continues. The eggs of one beetle can produce enough beetles to **colonize** 15 more trees!

Generally, the life cycle of the mountain pine beetle is as follows:

Alberta Sustainable Resource Development

Mountain pine beetle life cycle

This cycle is usually one year, but may take two years to complete if conditions are not favourable (e.g. rainy summers, cool summers, high altitudes).

What Role Does it Play in the Forest?

The mountain pine beetle (MPB) prefers mature large pine trees and can kill them within one year of attack. By selecting aging, stressed, large pine trees, the beetle plays a role in helping to renew the forest through a process called **succession**. Succession is the term used to describe the process by which a forest originates, grows and changes over time. Initially, the dead trees provide food and shelter for other species. Eventually, the nutrients of the trees are broken down and returned to the soil. By removing the larger trees, more light and space are available for young trees to grow.

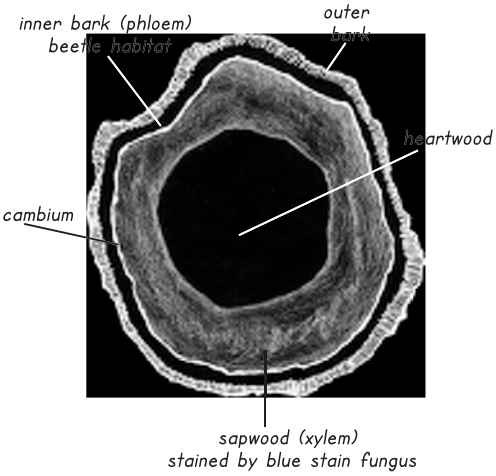
The MPB is also a food source for some bird, mammal and other insect species. In particular, woodpeckers have adapted to find and eat bark beetles under the bark.

How do Bark Beetles Kill a Tree?

Once a female beetle colonizes a new host tree, she releases **pheromones** that attract other female and male beetles to the tree – meaning a successful MPB colonization always involves many more than one beetle. The sharp mouthparts of the adult mountain pine beetle are ideally suited for boring through the

bark to make the long, vertical galleries where the eggs are laid. It is also those mouthparts that carry **blue stain fungus** (their body carries it too). Blue stain fungal spores clog up the tree's water-conducting vessels, or **xylem**.

In addition, the larvae cause even more direct feeding damage than the adults. They tunnel horizontal galleries around the tree. These galleries **girdle** the tree and disrupt the phloem layer. The phloem is important because it transports nutrients throughout the tree. By disrupting both the xylem and phloem of pine trees, the MPB larvae and their accompanying blue stain fungus make a deadly combination. The girdling of the tree and cutting off nutrient flow in the phloem layer is what causes the tree to die so quickly – within one year of colonization, in most cases.



Signs and Symptoms

If you suspect mountain pine beetle colonization, look for the following **signs** and **symptoms**:

Outside the Tree

- Yellowish-green to reddish-brown needles throughout the crown of the attacked pine. Depending on the time of year, the needles will turn from green to red within a year of colonization. Usually once the needles turn red, the tree is dying or dead and the majority of the beetles have moved to another tree.
- Cream coloured resin (pitch) that looks like crystallized honey oozing out of beetle entry holes (**pitch tubes**) on the tree trunk. The tree's natural defense against the MPB is to try to "pitch" the beetle out of the tree by a flow of sap or pitch. Sometimes the tree can successfully get rid of the beetles before the gallery is completed and before major damage has occurred. These trees will not usually die.
- Round exit holes where the adult beetles have left the tree the following year will also be evident
- Boring sawdust found in bark crevices and around the base of the tree
- An abundance of woodpecker evidence (flaked off bark, especially) can also indicate a colonized tree

Under the Outer Bark

- Egg galleries (j-shaped and up to 41 cm long) under the bark, beginning above the entrance holes and running along the grain of the wood
- Larval galleries girdling around the tree
- Presence of eggs, larvae, pupae and/or beetles
- Greyish blue sapwood caused by blue stain fungi carried by the beetles

So What Has Changed?

Normally, MPB populations are kept in check by natural factors such as predators, parasites, wet summers, and early, cold winters (-30 ^{o}C or lower in November) or late, cold springs. (Mountain pine beetle larvae survive cold winters by producing an insect antifreeze called glycerol.) The harsh weather conditions are the most effective in controlling the population. Forest fires also control MPB populations because they often eliminate large numbers of available host trees and, if hot enough, can kill beetles under the bark.

The limiting or prevention of forest fires on the landscape has resulted in large continuous areas of mature pine trees that are older than 80 years – the MPB's favourite **habitat**. (However, the beetles are also starting to colonize younger and smaller pine trees.) This has resulted in large-scale MPB **outbreaks** in British Columbia and an ever-increasing **risk** in Alberta. Because many of British Columbia and Alberta's lodgepole pine forests are of this age, this insect can be a serious threat to the **biodiversity** of forests.

What is the Mountain Pine Beetle?

cont'd

Another recent contributing factor is the general warming climate trend. Since the winters are not getting cold enough to kill the beetle, it is able to survive the winter and continue to reproduce. This has also allowed it to expand its range further north and east than its historical distribution. There is also an added risk that the mountain pine beetle could adapt to jack pine trees. This could result in the mountain pine beetle eventually moving east across Canada.

From a human perspective, there is a also a greater reliance than ever before on the forest to meet a variety of economic and social needs. The widespread MPB outbreak in British Columbia has had significant economic and social impacts on the forest products industry (B.C.'s largest industry), communities and tourism. Loss of income, resources and jobs are a result of the growing issue of MPB outbreaks.

What Can be Done?

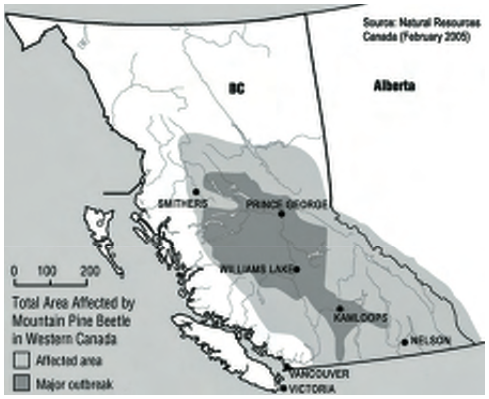
There are no easy answers to this question!
Forest management to deal with the spread of the MPB is not a simple task. Managing the beetle has proven to be difficult in B.C. where the insect has affected over 7 million **hectares** of pine forest. In addition to the large size of the area affected, many different land objectives and land managers are involved. This requires careful but timely consideration.

In Alberta, there are two main approaches to mountain pine beetle control: a short-term strategy that focuses on the beetle and a long-term one that focuses on beetle-susceptible pine stands.

The beetle is difficult to control. It is protected under the bark most of its life and the tree dies quickly after being colonized. Chemicals in general do not work because they usually end up damaging the tree and affecting other species that use the tree.

Therefore, the beetle strategy focuses on limiting the spread of the **infestation** before it reaches outbreak levels and containing the population when it becomes an outbreak. This strategy requires prevention, monitoring for early detection, and quick control of infestations when the populations are small. To reduce the risk of mountain pine beetle-colonized logs being moved from an infested area to a new area, Alberta restricts the transportation of pine logs with bark attached, especially during the summer beetle flight. This includes firewood!

Ground and **aerial surveys** are used to monitor MPB populations. Detection is difficult because the main identifying characteristic of a MPB-infested tree — red needles — is good evidence to find out where the mountain pine beetles *were*, not *where they are*, and even more difficult, *where they are going*.



Total area affected in British Columbia and Alberta as of February 2005.

The control usually involves removal of colonized trees by either **prescribed burning** or cutting down trees soon after detection before the adults leave to find new trees. The cut trees are then destroyed by burning, peeling off the all the bark or processing them. Once the population reaches high levels (outbreak), pheromone **baits** can be used to attract and contain the beetles in a given area designated for future tree removal. Individual tree removal also continues on the edges of the infestation to prevent spread.

The long-term strategy involves reducing future threats of mountain pine beetle outbreaks by carefully planning to replace highly susceptible contiguous mature lodgepole pine stands with less susceptible stands of mixed species and **age classes**. These stands will then be more resilient to insect outbreaks, less susceptible to large wild fires and have improved wildlife habitat. The approaches to create a more diverse forest would include: prescribed burning, reduction of **MPB-susceptible host** trees and harvesting of stands (earlier than normal) to reduce the available host trees for beetles. Replanting with species other than pine, where possible, could also be implemented.

What is the Mountain Pine Beetle?

cont'd

Summary

It is important to keep in mind that the mountain pine beetle is native to B.C. and some parts of Alberta and does have a role to play in a healthy forest. But things have changed. A general climate warming trend and years of **fire suppression** have created large areas of good beetle habitat, which has been favourable for its expansion. This is a grave concern as society increases its reliance and places higher values on the forest to meet a variety of social, economic and environmental needs.

To help address this large and complex issue an inter-provincial/inter-agency working group was formed. The *Mountain Pine Beetle Strategic Direction Council* consists of Natural Resources Canada's Canadian Forest Service, Parks Canada, Alberta Sustainable Resource Development, Alberta Community Development, forest industry representatives (Hinton Wood Products and Spray Lake Sawmills), B.C. Ministry of Forests and Range and B.C. Parks. This group shares the same objective of minimizing the impact of the eastern and northern expansion of the mountain pine beetle. It works collaboratively to protect the economic values of the provincial and working forests and to achieve the ecological objectives of national and provincial parks and protected areas.

Glossary of Terms

Aerial survey Identifying suspected MPB killed trees from a fixed wing plane or helicopter. Beetle-killed trees are identified by the discoloration of the needles within the first year of colonization.

Age distribution The range of tree ages in a forest stand.

Age-class distribution The distribution of different age classes within the population being examined. (Dictionary of Natural Resource Management)

Baiting The use of synthetic pheromone baits to detect the presence of MPB in a new area or to monitor changes in the population. It can also be used to attract the beetles to a given forested area that will be controlled.

Biological diversity (biodiversity) The variety and variability within and between living organisms from all sources such as terrestrial, marine and other aquatic ecosystems, and the ecological complexes they are a part of.

Blue stain fungus One of several fungi that has a symbiotic relationship with the MPB. The spores of the fungus are carried from tree to tree in the beetle's mouth pouches. The fungi stains the wood blue.

Cambium The living layer of the tree between the sapwood and inner bark that produces the new phloem and xylem.

Climate change Changes in climate (such as temperature, precipitation, wind) that depart significantly from previous average conditions and are seen to endure, bringing about corresponding changes in ecosystems and socioeconomic activity.

Colonization The establishment of a species in an area that is not currently occupied by that species. (Dictionary of Natural Resource Management)

Cut and burn A treatment option that includes the cutting and burning of either a single tree or small patches of trees that are currently infested. The purpose from a forest health perspective is to destroy the beetle population in the trees.

Cut and peel A treatment option that includes hand falling and peeling (removing) the bark off either a single tree or small patches of trees that are currently infested. This method exposes the beetles to the elements and they die from exposure.

Declining population The last stage in an epidemic cycle where population levels decrease to their normal, or endemic, levels. This stage is caused by lack of suitable hosts and/or harsh climatic conditions that increase beetle mortality.

Endemic population The normal population native to the area that is kept in check by natural factors. It is the first phase of a mountain pine beetle epidemic cycle.

Epidemic population A population of an organism that is well above the endemic level. It is a temporary, large-scale outbreak. In the case of MPB, the population has the ability to infest almost all of the mature pine trees in the forest stand. Natural factors are no longer effective in beetle control.

Fire hazard The level of risk for ignition and/or spread of fire in a forest. A general term to describe the potential fire behaviour, without regard to the state of weather-influenced fuel moisture content, and/or resistance to fireguard construction for a given fuel type. (www3.gov.ab.ca/srd/wildfires/fpd/mfp/mfp_manuals.cfm)

Fire suppression All activities concerned with controlling and extinguishing a fire following its detection. (www3.gov.ab.ca/srd/wildfires/fpd/mfp/mfp_manuals.cfm)

Forest stand A group of trees in a given area that have similar characteristics (e.g. age or species) and can be uniquely distinguished from adjoining areas.

Gallery A tunnel carved into the inner bark of the tree by the adult mountain pine beetle to lay eggs or by larvae for food.

Girdling A term used to describe the damage done to the phloem layer (inner bark) around a tree. Girdled trees will often die because the flow of nutrients and water is broken between the needles and the other parts of the tree, such as the roots.

Ground survey A survey that involves walking into a forest and making forest health observations of a given area. If suspected MPB-killed trees are identified from an aerial survey, a scientist will head out to a site to confirm the presence of the MPB.

Growing season The length of time in a year in which trees are actively photosynthesizing. The frost-free part of any one year. (Dictionary of Natural Resource Management)

Habitat The area in which an organism usually lives.

Hazard The condition of stands (susceptibility) and the prevailing environmental conditions (such as climate) that are conducive to a mountain pine beetle attack. Does not include the probability that this will occur.

Glossary of Terms cont'd

Hectare An area 100m long by 100m wide – just under the size of two football fields.

Host The plant or animal on which an insect feeds.

Host susceptibility The lack of ability of a host species to withstand MPB colonization. Factors that could affect susceptibility would be tree age, tree diameter, tree species and tree stress.

Incipient A population of an organism that is on the rise due to a lack of at least one limiting factor.

Infestation A large-scale temporary increase in numbers in a given location, where the insect and its damage are noticeable.

Larva An immature life stage of an insect. It emerges from an egg. It the case of the MPB, this stage causes the most damage to the tree.

Limiting factors Any factor (biotic or abiotic) that inhibits the growth of a species population.

Mortality The death rate in a population of organisms.

Mountain pine beetle A native bark beetle species that feeds on the inner bark of pine trees of western North America.

Natural controls Methods of controlling organism populations without human intervention.

Natural enemies The parasites, parasitoids, predators, and pathogens associated in nature with a specific wild population of plants or animals.
(Dictionary of Natural Resource Management)

Outbreak A large-scale temporary increase in population causing severe damage over a large geographic area.

Parasite An organism that benefits from a relationship while negatively affecting its host.

Pesticide A substance used to kill a pest in an area. Examples include insecticides (for unwanted insects) and herbicides (for unwanted plants).

Pheromones A chemical hormone released by an organism for communication in the same species; e.g. pheromones released by female beetles attract other female and male beetles to the tree.

Phloem The food-conducting tissue of the tree that forms the main component of the inner bark.

Pitch tubes Small blobs of pitch secreted by the host tree in its efforts to trap and prevent the MPB from entering the stem.

Prescribed fire Fire that is intentionally set by qualified fire management personnel according to predetermined objectives and burning conditions for a certain purpose. Examples of prescribed burn objectives might include controlling forest insects and exposing rich mineral soil for growing plants.
(Canadian Interagency Forest Fire Centre glossary.)

Pupa A stage of transition (between larva and adult) in an insect's life. It is inactive during this time.

Risk The probability of a MPB attack in a stand. The factors that could increase risk may include high susceptibility, high hazard, high potential of beetle movement into the stand, and high beetle population levels close to the stand.

Salvage harvesting The harvesting of the beetle-killed timber before the wood quality degrades to a level below merchantability. The purpose of the harvest is maximizing the timber profit of beetle-killed timber.

Sanitation harvesting A treatment option that involves harvesting then processing trees at a mill to reduce the beetle population and prevent its spread to healthy stands.

Severe weather Extreme weather events that result in unusually harsh weather, such as colder than normal temperatures, heavy winds, blizzards, and tornadoes.

Sign Visible evidence of the presence of a specific insect or pathogen. For example, the presence of larvae and adults and the larval and egg gallery characteristics can be used to identify mountain pine beetle.

Species diversity The variety of species and their distribution and abundance in a habitat.

Succession The orderly process of change over time in an ecosystem where an early pioneering community is replaced by another until a stable 'climax' community is reached.

Symbiosis A relationship between two organisms in which both organisms benefit.

Symptom The visible reaction of a host tree to an attack by the mountain pine beetle. Pitch tubes are a good example of a symptom.

Xylem The main water- and nutrient-conducting tissues of the tree; the main component of sapwood.

Mountain Pine Beetle
Extension

Answer the following questions based on the information given in the Primer or your own research.

1. Describe the four stages in the development of the mountain pine beetle.

   1 _____

   2 _____

   3 _____

   4 _____

2. How long is the average life cycle of the mountain pine beetle?

   _____

3. What conditions can affect the length of the life cycle of the mountain pine beetle?

   _____

   _____

   _____

4. Write a newspaper article on the process of the mountain pine beetle colonizing and killing a pine tree as if your headline read: Tag Team Pair Wreaking Havoc

5. Why do you think that the mountain pine beetle is more attracted to older pine trees? (hint: think about where in the tree they spend most of their time)

   _____

   _____

   _____

Beetle Doodle

Journal Activity

Purpose

- to create a visual journal to record learning over the course of the program

Materials

- sheet of 8.5 x 11 white paper

Time Needed

- 5 minutes after each MPB lesson

Class Arrangement

- individual

Procedure

- Before starting the following activities, each student receives a blank sheet of white paper for use as both a title page and journal for the length of the program.
- At the end of each activity, students add a sketch or brief description of what they've learned over the course of that activity. (Both sides of the paper can be used.)
- Use the finished title page/journal as an assessment of student learning at the end of the program. The evaluation rubric is below.

Mountain Pine Beetle Title Page/Journal
Evaluation Rubric

CATEGORY	4	3	2	1
Information	All information presented on the title page is clear, accurate and thorough.	Most information presented on the title page is clear, accurate and thorough.	Most information presented on the title page is clear and accurate, but was not usually thorough.	Information has several inaccuracies OR is not clear.
Use of Facts and Statistics	Major points are well supported with several relevant facts, statistics and/or pictures.	Every major point is adequately supported with relevant facts, statistics and/or pictures.	Every major point is supported with facts, statistics and/or pictures, but the relevance of some was questionable.	Every point is not supported.
Understanding of Topic	The student clearly understood the topic in-depth and presented information effectively.	The student mostly understands the topic in-depth and presents information adequately.	The student understands the major points about the topic and presents information somewhat effectively.	The student does not show understanding of the topic well.
Completion and Organization	Title page space is well-filled with relevant information and organized logically.	Title page space is filled with relevant information and shows mostly logical organization.	Title page space is almost filled with relevant information and shows somewhat logical organization.	Title page space is not well-filled and information does not show logical organization.

Mountain Pine Beetle

What Do You Know About the Mountain Pine Beetle?

Pre- & Post-Survey

Purpose

- to assess student knowledge of the topic before the start of the activities
- to assess what learning occurred over the course of the program

Materials

- *What Do You Know About the Mountain Pine Beetle?* worksheet (one copy per student)
- *What is the Mountain Pine Beetle?* – A Primer for Teachers and Students (one copy per student)

Time Needed

- 30 - 60 minutes

Class Arrangement

- individual & small groups (4-6 students)

Procedure

- Students work through the mix of knowledge and attitude questions individually.
- After completing the survey individually, students get into small groups to discuss their answers. Questions are worded to provide for good discussion.
- After discussion, students re-circle answers to see if the discussion influenced and/or changed their answers.
- Extension: Have students read the *What is the Mountain Pine Beetle?* – A Primer for Teachers & Students and either discuss or write down answers to the five questions at the end of the Primer.

Answers

1. F **2.** T **3.** F **4.** F
5. F **6.** T **7.** F **8.** F

Questions 9-13 are attitude-based, but suggested answers are:
9. 1 **10.** 2 **11.** 5 **12.** 3 **13.** 1

Mountain Pine Beetle

What Do You Know About the Mountain Pine Beetle?

Name: _____

You are going to be learning about the mountain pine beetle and the effect it could have on Alberta's forests. Circle the appropriate number that corresponds to your opinion or knowledge about each statement.

Then, with your group, go through each statement and discuss what you know about the topic. Re-circle a number for each statement (with another colored pen/pencil) showing how your opinions changed (if at all) after discussion with your group.

1. Mountain pine beetle are currently found all across Alberta.	True		False		Don't Know
2. Putting out forest fires can help increase the spread of the mountain pine beetle.	True		False		Don't Know
3. A single mountain pine beetle can kill a tree.	True		False		Don't Know
4. The mountain pine beetle was introduced into Canada from Europe.	True		False		Don't Know
5. You can rarely tell if the mountain pine beetle has colonized a tree.	True		False		Don't Know
6. The mountain pine beetle is an important food source for some bird species.	True		False		Don't Know
7. Pesticides are the most effective way to kill the mountain pine beetle.	True		False		Don't Know
8. Mountain pine beetle mainly attack young, healthy pine trees.	True		False		Don't Know
9. Mountain pine beetle has had a huge effect on British Columbia's forests.	**1** Strongly Agree	**2**	**3** Neutral	**4**	**5** Strongly Disagree
10. The mountain pine beetle could have a big effect on you or your family.	**1** Strongly Agree	**2**	**3** Neutral	**4**	**5** Strongly Disagree
11. A healthy forest is a forest with no tree-killing insects or diseases.	**1** Strongly Agree	**2**	**3** Neutral	**4**	**5** Strongly Disagree
12. Mountain pine beetle needs to 'run its course' in the forest.	**1** Strongly Agree	**2**	**3** Neutral	**4**	**5** Strongly Disagree
13. The mountain pine beetle helps contribute to the biological diversity of a forest ecosystem.	**1** Strongly Agree	**2**	**3** Neutral	**4**	**5** Strongly Disagree

The Rise & Fall of the Mountain Pine Beetle

Purpose

- to understand the differences and connection between endemic, incipient, epidemic, and declining phases of a mountain pine beetle outbreak
- to understand that when natural controls are in place, mountain pine beetle populations stay in balance

Materials

- *The Rise & Fall of the Mountain Pine Beetle* Class Demonstration Script (one copy for teacher)
- *The Rise & Fall of the Mountain Pine Beetle* worksheet (one per student)
- graph paper, ruler, and pencils (one set per student)

Time Needed

- 60 Minutes

Class Arrangement

- individual and class

Vocabulary

endemic
incipient
epidemic
declining
limiting factors
outbreak
natural controls

Procedure

- Following the directions on the next page, lead the students through the class demonstration using *The Rise and Fall of the Mountain Pine Beetle* Class Demonstration Script.
- Using the remaining materials listed above (graph paper, ruler, pencils), students examine the rise and fall of mountain pine beetle populations while doing the graphing activity on *The Rise and Fall of the Mountain Pine Beetle* worksheet.
- Students graph how the population (y-axis) of mountain pine beetle changes over time (x-axis) with no human controls. They will then label each section of the line on the graph with where each of the phases is represented.
- Extension: students think about what happens to the graph when a major fire in an area wipes out most of the 60+ year old pine and what happens after several years of late fall or early spring –30 ^{o}C or lower temperatures that kill off many of the larvae.

Teacher Note: Sample graphs have bee
for you, but student graphs will vary dep
when they have the scenarios occur. Thes
are a good discussion tool – each student
be different just like in a forest ecosystem
areas will experience a fire or climate diff
different in

The Rise & Fall of the Mountain Pine Beetle cont'd

Class Demonstration Script

Introduction

We will use the following demonstration to model the normal (historical) pattern of outbreaks of MPB and the current outbreak of MPB in British Columbia that could happen in Alberta.

The following are limiting factors for the mountain pine beetle

1) woodpeckers

2) cold winters, wet summers

3) forest fire (hot!)

4) nematodes (small worms)

5) parasitic fungi

6) other insects

7) a lack of suitable pine trees

8) 'pitching out' – a natural defense by the tree

9) mountains that block the widespread distribution of the beetle

Procedure
(for a class of 25 – 30 students)

1. Endemic phase: Have the tallest five students in the class stand up. They represent the trees within the forest (the class) that are colonized by MPB. This phase of the epidemic cycle is called the 'endemic phase'. During this phase, MPB levels are low and they attack older, weaker trees randomly. This is considered to be a 'normal' beetle population. Under normal circumstances, climatic conditions and predation keep the beetle levels in check. The beetles perform an important role in the ecosystem because they remove mature trees from the canopy, allowing younger trees to grow up in their place. This stage will last until one of the limiting factors is removed. Have three of these students sit down because the beetles have been killed by cold, fire, or predation.

2. Incipient phase: During the 'incipient' phase, beetle numbers increase because at least one of the limiting factors is missing (i.e. no forest fire in the area, warm winters, abundance of host pine trees). Have ten of the remaining tallest students in the class stand up with the other two. The beetle attack is still random, but the number of trees affected increases.

3. Epidemic phase ('Outbreak'): When the number of beetles within a forest ecosystem reaches a certain number, they have the ability to colonize almost all of the mature trees, and even some of the younger trees, in a forest. At this stage, none of the limiting factors, and even human controls, can restore the balance. Have the students who are 'colonized' with MPB tag another student nearby and have them stand up too. If any remaining students are within arm's reach of a 'colonized' student, they must stand up. This is the 'epidemic' phase.

4. Declining phase: In the final stage of the epidemic cycle, the number of beetles declines because of a lack of suitable hosts, or because of fire and/or cold conditions, bringing the population back down to normal 'endemic' levels. Have all but one of the students in the class sit down (choose one student at random to remain 'colonized'). Look around the class at all of the 'dead' trees. What will happen now? (Student answers will vary, but possible answers could be: young seedlings can grow up in the shadow of the dead trees from seeds dropped from cones, remaining beetle population will have to migrate to another older pine forest for food/habitat, forest companies could possibly use some of the timber.)

Mountain Pine Beetle

The Rise and Fall of the Mountain Pine Beetle

Name: _____

Using the following definitions and your graph paper, sketch the pattern the mountain pine beetle follows in becoming an epidemic in the forest. Your graph should have the population level of the MPB on the y-axis and time on the x-axis. Draw a line to represent the change in population level as the MPB passes through each phase and label each section of the line on the graph with where each of the phases is represented:

1. **Endemic phase** – very low populations of beetles randomly attack weak and old trees throughout the forest. Volume growth of trees still remains higher than what is being killed by the beetle.
   Timeline: this stage can last for decades. (For this example, use 10-20 years.)
2. **Incipient phase** – increased migration of beetles from infested areas, favourable weather conditions (warm winters), and decreased effectiveness of natural controls (e.g. bird predators) cause increased numbers of infested trees.
   Timeline: this stage can last for 2-3 years.
3. **Epidemic phase** – usually only in areas with many mature host trees. Large population outbreaks of beetles cause wide-scale tree mortality.
   Timeline: this stage can last several years if there are enough hosts available.
4. **Declining phase** – a lack of host trees or unfavourable climate conditions (e.g. cold winters) cause increased beetle mortality.
   Timeline: this stage can last a few (2-3) years and leads back to the endemic phase.

Choose *one* of the following to complete this activity:

Extension 1

Draw the same x- and y-axis labels on a new graph. Mark a vertical line along the x-axis representing a major fire in an area that wipes out most of the 60+ year old pine during the incipient phase of a beetle epidemic cycle. Now re-draw the stages of the MPB, showing how the beetle population will change because of the fire. How is this graph different than your first one?

Extension 2

Draw the same x- and y-axis labels on a new graph. Mark a few vertical lines along the x-axis representing several years of late fall or early spring –30 ^{o}C or lower temperatures that kill off many of the larvae during the epidemic phase of a beetle epidemic cycle. Now re-draw the stages of the MPB, showing how the mountain pine beetle population will change because of these years of weather effects. How is this graph different than your first one?

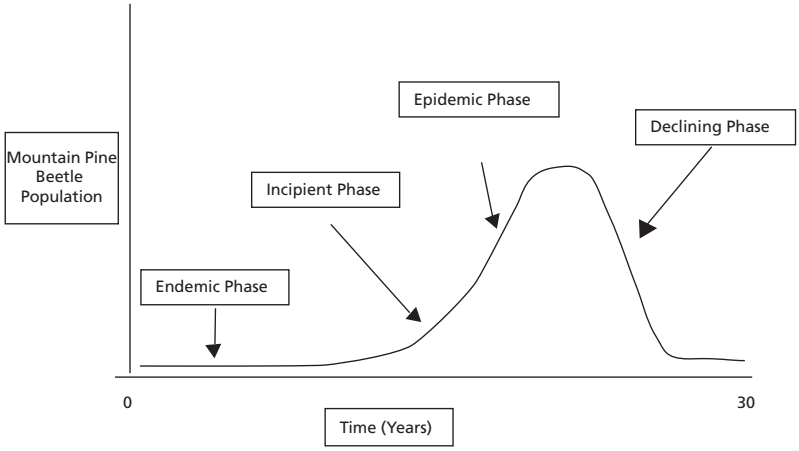
Extension 3

In your own words, tell the story of a MPB infestation in a pine forest. Be sure to use the following terms: endemic phase, incipient phase, epidemic phase, declining phase.

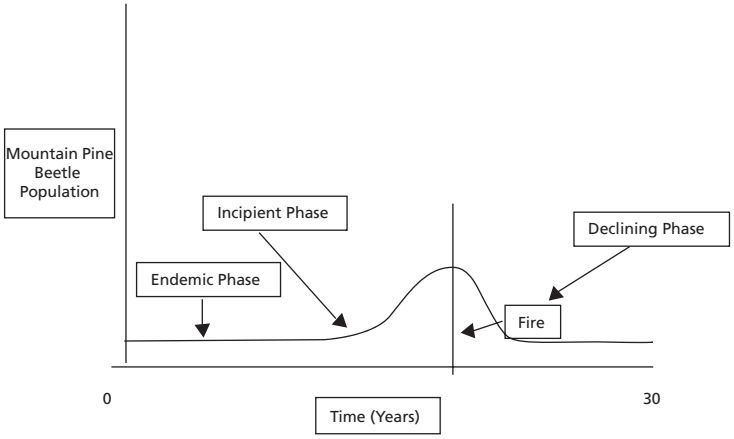
Mountain Pine Beetle cont'd

Sample Student Answers

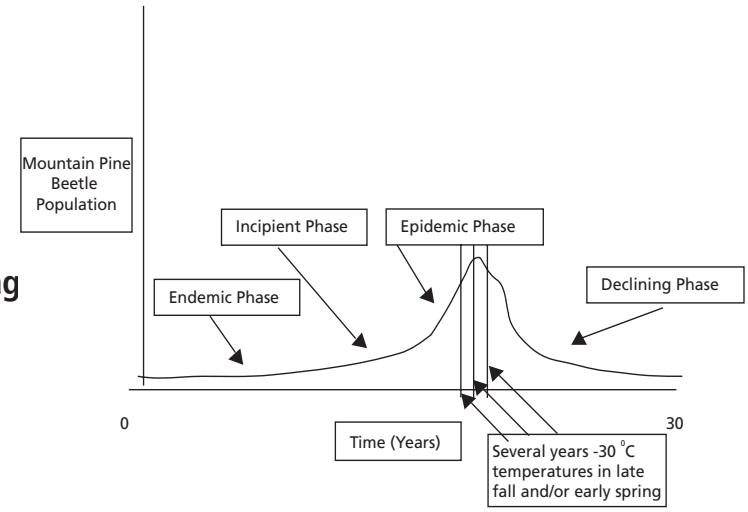
Mountain Pine Beetle Typical Population Growth



Extension 1
A Fire Removes Most of the 60+ Year Old Pine



Extension 2
Several Years of –30 ^{o}C or lower Temperatures in Late Fall or Early Spring



Examining Epidemics

Purpose

- to use maps and data to analyze how MPB epidemics have occurred in the past and may occur in the future

Materials

- computer lab time to access to the following websites:

  www3.gov.ab.ca/srd/forests/health/index.htm

  www.for.gov.bc.ca/hre/bcmpb/cumulative/title.htm

- *Examining Epidemics* student worksheet (one set of questions/graphs per student or pair)

Time Needed

- 45-60 minutes

Class Arrangement

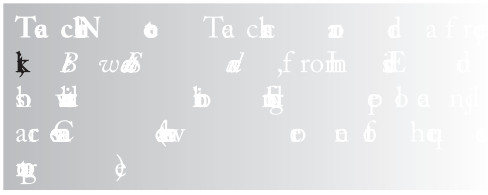
- individual or pairs

Vocabulary

Historical outbreaks
Mean monthly temperature
Climate change

Procedure

- Have students set themselves up in the computer lab and bookmark the two websites noted previously.
- Have students work through the questions listed on the *Examining Epidemics* worksheet while in the computer lab.



Answers

1. - southwest Alberta
   - good habitat and climate for MPB success
2. Cold November temperatures killed off many MPB larvae.
3. - Larvae are not adaptable to cold temperatures.
   - An increase in temperature could mean increase in MPB populations.
4. Any community in the boreal forest
5. ~33%, ~45%, ~70%

Mountain Pine Beetle
Examining Epidemics

Name: _____

Mountain pine beetle outbreaks have occurred in the past, but not with the severity of the current outbreak in British Columbia. Governments, industry, and other land managers in Alberta have been keeping track of MPB outbreaks in order to learn more about how and when these events occur.

Using the Alberta Government's and the British Columbia Government's mountain pine beetle websites, and the charts and maps that have been provided, answer the following questions:

1) Examine the historical maps of MPB outbreaks at **www3.gov.ab.ca/srd/forests/health/mpb_cond.html.** Where in Alberta have outbreaks historically occurred? Why might the outbreaks be happening in these areas specifically?

_____

_____

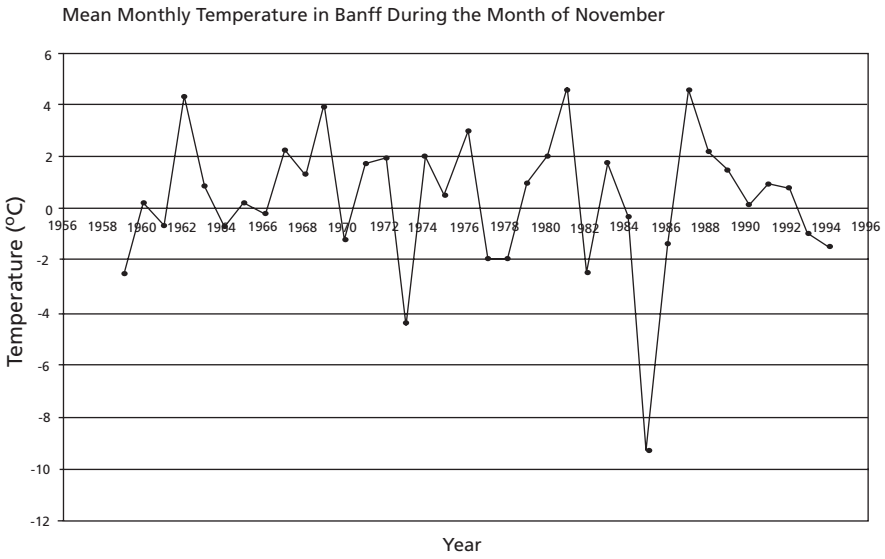
_____

2) Look at the 1985 historical map at **www3.gov.ab.ca/srd/forests/health/mpb_cond.html** and the *Mean Monthly Temperature in Banff During the Month of November* graph below. Explain why you think the MPB outbreak of 1985 did not continue to 1986.

_____

_____

_____



Mountain Pine Beetle

Examining Epidemics

3) Why is the temperature in November particularly important to the MPB? How could an overall increase in temperature due to climate change affect the population of MPB?

_____

_____

_____

4) The MPB has severely affected an ecoregion of Canada know as the Montane Cordillera, which is characterized by the presence of lodgepole pine. Forest scientists fear that the beetle may adapt to be able to colonize jack pine (a species related to lodgepole pine). Using the internet or map provided by your teacher, find out where in Alberta you could find jack pine (Hint: Look up Boreal Plains).

List at least 5 communities in Alberta that could be directly affected if the MPB does begin to colonize jack pine.

_____

_____

_____

5) Using the Provincial Level Projection of the Current MPB Outbreak slide show at **www.for.gov.bc.ca/hre/bcmpb/cumulative/title.htm**, estimate:

a. The per cent of British Columbia covered with pine trees.

_____

b. The per cent of those trees that have been affected by the MPB.

_____

c. The per cent of those trees that are expected to be killed by the MPB by the year 2014.

_____

Mountain Pine Beetle

What's the Problem?

Purpose

- to understand that climate change and fire suppression have had and probably will have the biggest effect on mountain pine beetle populations
- to think about the effect mountain pine beetle populations have on humans and introduce the role humans have in healthy forest management

Materials

- *What's the Problem*? worksheet (one per student or group)
- large sheet of chart paper
- markers

Time Needed

- 45 minutes

Class Arrangement

- pairs or small groups for mind map, individually for remaining questions

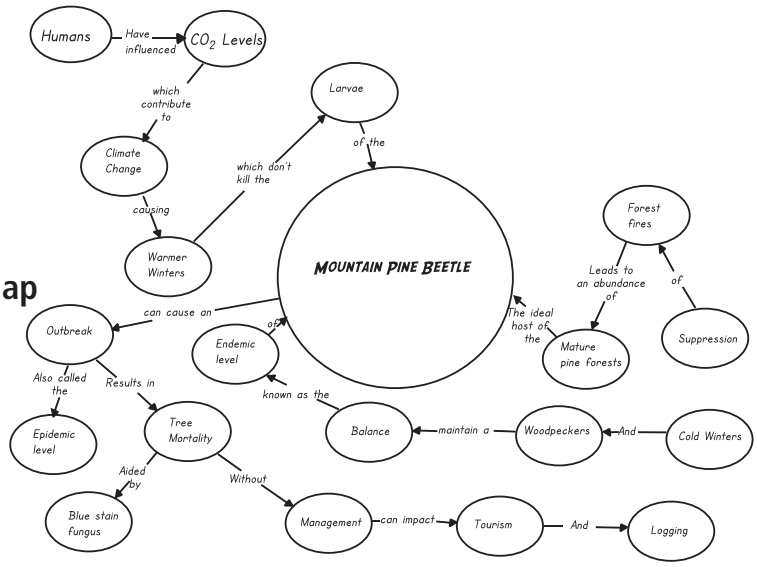
Vocabulary

Climate change	Severe weather event
Mortality	Growing season

Procedure

- Discuss the idea of a 'mind map' for students who have not done one before – key concepts are linked together to form cause and effect statements all leading back to the main focus: the mountain pine beetle.
- A sample mind map has been included for your use – you may want to start with one common example for all groups if students are new to this style of activity.
- Students work individually on the questions following the mind map laid out in the *What's the Problem?* worksheet.
- As a class, discuss answers to the questions, making a list of all the effects massive pine mortality could have on the activities humans participate in (from individual activities like hiking to major industrial activities like forest harvesting).

Sample Mind Map



Mountain Pine Beetle

What's the Problem?

Name: _____

The mountain pine beetle is at the centre of a big challenge. In this activity, you will look at how the MPB is affected by and affects others and then connect how human activities in the forest could be affected by an increased MPB population.

1. *The Six Degrees of Mountain Pine Beetle*

   Create a 'mind map' linking the mountain pine beetle to the factors that affect it or that it affects. Using a large sheet of paper, a marker, and the key concepts relating to mountain pine beetle below, your job is to take the key concepts and arrange them into a logical train of thought (cause and effect) using lines and arrows. You need to connect the concepts using logical statements. Feel free to add in any additional concepts to help with your map.

   Key concepts for the mountain pine beetle:

climate change	**forest fire**	**outbreak**	**warmer winters**	**fire suppression**
larvae	**woodpeckers**	**tree mortality**	**humans**	**endemic levels**
balance	**CO_2 levels**	**stressed pine**		

2. Brainstorm what outdoor activities you participate in during the year (e.g. camping, fishing, ATV-ing, skiing, hunting).

   _____

   _____

   _____

3. Outline the positive and negative effects that massive pine forest mortality due to increased mountain pine beetle will have on those activities.

   _____

   _____

   _____

4. Pick one major industry active in Alberta's forests and outline the positive and negative effects increased pine mortality from mountain pine beetle may have on that industry.

   _____

   _____

   _____

Mountain Pine Beetle

Stopping the Spread

Purpose

- to give students an awareness of the variety of choices that can be made regarding the management of mountain pine beetle

Materials

- *Stopping the Spread* student worksheet (one per student)

Time Needed

- 60 minutes (Part 1, 2, and introduction to 3)
- 60 minutes (Part 3 small group discussion & town hall meeting)

Class Arrangement

- individual (Part 1 & 2)
- small groups (Part 3)

Vocabulary

species diversity
age distribution
prescribed fire
cut and burn
cut and peel
sanitation harvesting
host
forest stand
fire hazard
infestation

Part 1 Answers

cut and burn	C
sanitation harvesting	E
cut and peel	D
prescribed fire	B
harvesting at-risk stands	A

Procedure

- Students work through Part 1 & Part 2 individually using the *Stopping the Spread* worksheet.
- The main techniques used for controlling the spread of MPB in Alberta (cut and burn, cut and peel, sanitation harvesting, reduction of beetle habitat through prescribed fire, encouraging tree species diversity and a wide age range of trees) are explained in Part 1's matching activity.
- Part 2 has students think about what management options could be used when (e.g. when populations are low or endemic, in the incipient phase, at small-scale epidemic levels, or at larger-scale epidemic levels).
- For Part 3, divide students into small groups (2-3 students per group) and assign them one of the listed perspective groups.
- Outline the 'Town Hall' debate that all students will be participating in and what the situation is around the town with respect to the MPB situation. Each group needs to examine the chart on their worksheet and come up with at least two to three ideas on what they would do if they were that person and at least two to three ideas on how that would affect the other groups and possible compromises they could make to address those effects.
- Hand out the evaluation rubric before beginning the debate so students know how they will be evaluated.
- Give students approximately 30 minutes to prepare their presentation and be prepared to be the facilitator of the debate. Once each group has presented on their perspective, facilitate discussion where groups attempt to come up with a plan for the area around the town.
- Once a plan has been reached, summarize the activity by discussing how in the 'real world', decisions are never easy and compromise is necessary in order to balance the needs of all the users of the forest as well as the needs of the ecosystem.

Mountain Pine Beetle

Stopping the Spread Part 1

Name: _____

You should now have some understanding of the mountain pine beetle and many of its effects on the forest. In Alberta, we have different options for managing the MPB and hopefully controlling its spread. In this activity, you will work through several small exercises to determine which of these options is most useful in which situations.

Match the possible management option in the left column with its description in the right column.

Short-term options

____ cut and burn

____ sanitation harvesting

____ cut and peel

Long-term options

____ prescribed fire

____ harvesting at-risk stands

A) Removing vulnerable stands in the path of the outbreak to promote the growth of various tree species (e.g. spruce, pine, aspen) that reduce the number of hosts for mountain pine beetle.

B) Fire that is intentionally set and controlled to encourage a wide age distribution of trees and reduce the habitat available for the beetle.

C) An infested tree is cut before the beetles emerge, cut up into smaller pieces, and burned until, at a minimum, bark is completely charred.

D) An infested tree is cut before the beetle emerges and the bark is peeled off both the felled tree and the stump.

E) The infested trees are harvested (magnitude depends on the size of the outbreak) and the beetles are killed in the process of making the tree into a product.

Mountain Pine Beetle

Stopping the Spread Part 2

1. Pick one of the forest treatments in Part 1 and brainstorm what you think might be one advantage and one disadvantage to using that technique rather than another.

   Advantage _____

   Disadvantage _____

2. For the different situations below, consider what of the forest treatments listed in Part 1 you would choose if you were the land manager for the area. Be sure to write why you chose a particular option.

   a) There is an outbreak in an area that has had a very dry spring and where the fire hazard is quite high.

   _____

   _____

   _____

   b) There is a small infestation in an area that is not easily accessible by machinery.

   _____

   _____

   _____

   c) There is an outbreak that covers a large area with many trees affected.

   _____

   _____

   _____

   d) There is an infestation in an area that is very sensitive ecologically.

   _____

   _____

   _____

Mountain Pine Beetle

Stopping the Spread Part 3

As a class, you are going to debate which of the above strategies should be used in your area. The situation is as follows:

> **You live in a large town on the eastern side of the Rockies. The mountain pine beetle has crossed from British Columbia into Alberta through the mountains over the past few years and has now killed hundreds of trees around your town. You are invited to a 'town hall' style debate in which you will try to sway the local politician (your teacher) to act on the beetle problem in a way that benefits you. You will be grouped and given a perspective to debate from.**

Your group may be one of the following:

- homeowner in town
- tour operator (i.e. whitewater rafting company or trail ride outfitter)
- oil and gas company
- national park staff
- the local Chamber of Commerce
- a "leave no trace" camping group
- provincial government forestry staff
- private landowner
- forester with a forest company
- local Aboriginals

How do you want the problem dealt with? How will you make sure that the politician will keep your interests in mind?

_____

_____

_____

_____

_____

Once you are in your groups, use the following chart and all of the information you have learned to guide your preparation for the town hall meeting:

If I was the following person, _____, and was dealing with MPB in the forest surrounding my community…	…what would I do…	…and what would be the effects on the other groups in my community?

Mountain Pine Beetle Management Town Hall Meeting

Evaluation Rubric

Name: _____

CATEGORY	4	3	2	1
Respect for Other Teams	All statements, body language, and responses were respectful and were in appropriate language.	Statements and responses were respectful and used appropriate language, but once or twice body language was not.	Most statements and responses were respectful and in appropriate language, but there was one sarcastic remark.	Statements, responses and/or body language were consistently not respectful.
Information	All information presented in the debate was clear, accurate and thorough.	Most information presented in the debate was clear, accurate and thorough.	Most information presented in the debate was clear and accurate, but was not usually thorough.	Information had several inaccuracies OR was usually not clear.
Rebuttal	All counter-arguments were accurate, relevant and strong.	Most counter-arguments were accurate, relevant, and strong.	Most counter-arguments were accurate and relevant, but several were weak.	Counter-arguments were not accurate and/or relevant.
Use of Facts and Statistics	Every major point was well supported with several relevant facts, statistics and/or examples.	Every major point was adequately supported with relevant facts, statistics and/or examples.	Every major point was supported with facts, statistics and/or examples, but the relevance of some was questionable.	Every point was not supported.
Presentation Style	Team consistently used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	Team usually used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	Team sometimes used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	One or more members of the team had a presentation style that did not keep the attention of the audience.
Organization	All arguments were clearly tied to an idea (premise) and organized in a tight, logical fashion.	Most arguments were clearly tied to an idea (premise) and organized in a tight, logical fashion.	All arguments were clearly tied to an idea (premise) but the organization was sometimes not clear or logical.	Arguments were not clearly tied to an idea (premise).
Understanding of Topic	The team clearly understood the topic in-depth and presented their information forcefully and convincingly.	The team clearly understood the topic in-depth and presented their information with ease.	The team seemed to understand the main points of the topic and presented those with ease.	The team did not show an adequate understanding of the topic.

Mountain Pine Beetle

Pine Beetle Squares Wrap-Up Activity

Purpose

- to wrap-up the mountain pine beetle program
- to quickly assess student knowledge learned over the program

Materials

- one set of nine sheets of paper with a large 'X' on one side and a large 'O' on the other
- list of questions (below) to ask student volunteers

Time Needed

- 20 Minutes

Class Arrangement

- class activity

Procedure

- Follow the same rules as the TV game show 'Hollywood Squares'.
- Nine student volunteers come up to the front to be the game board (top row needs to stand on chairs or counter, middle row stands on the ground, front row sits on chairs). Each of the nine game board members hold a card beside them until they answer a question.
- The rest of the class is divided in half (an 'X' team and an 'O' team). One team is chosen to go first. They ask one member of the game board to answer a multiple-choice or true/false question posed by the teacher. The team then needs to decide whether they 'agree' or 'disagree' with the game board player's answer. If they agree or disagree correctly, their letter goes up on the game board, if not the other team's letter goes up instead (unless it's for the win—team needs to answer their own question to win).
- If no team can finish a line, the team with the most letters on the board wins.
- This activity can also be used as a introductory activity to the program.

Pine Beetle Squares Questions

1) The mountain pine beetle is a native insect to which of these provinces of Canada:
   a) New Brunswick
   b) Ontario
   c) British Columbia

2) What do we call the tree that forest insects damage?
   a) Host
   b) Unlucky
   c) Carrier

3) The main Alberta host of the mountain pine beetle is:
   a) White spruce
   b) A nice person in Canmore who actually likes the beetle.
   c) Lodgepole pine

4) The mountain pine beetle larvae feed on the _____ of the tree.
   a) Phloem (inner bark)
   b) Leaves
   c) Fruit

5) Once female mountain pine beetles have successfully colonized a tree, how long does it usually take to kill* that tree?
   a) Three days.
   b) Two years.
   c) One season to one year
   **MPB will not always kill the tree; the tree can sometimes 'pitch' them out.*

6) Flying above a forest, how can you tell that an area has a mountain pine beetle outbreak?
   a) The trees are black looking like a burn after a forest fire.
   b) The trees are red from the needles changing colour as the tree dies.
   c) There are no branches left on the tree.

7) TRUE OR FALSE: Mountain pine beetles always have a one year life cycle.
   False: It may take two years to complete the life cycle in higher elevations or under other unfavourable conditions.

8) The major natural control for a mountain pine beetle outbreak is:
   a) A cold early or late winter (-30 ^{o}C or lower) when the beetles are in their larval stage.
   b) A very warm winter, as the beetle larvae need cold weather to develop properly.
   c) A big forest fire that kills the host pine trees.
   d) Either a cold winter or a big forest fire.

9) The mountain pine beetle has what kind of a relationship with the blue stain fungus*?
   a) Parasitic (the beetle benefits, but has a negative effect on the blue stain fungus)
   b) Symbiotic (the beetle and the blue stain fungus benefit from their relationship)
   c) Commensalistic (the beetle benefits, and has no effect on the blue stain fungus)
   ** Blue stain fungus is carried to new trees by the mountain pine beetle and in turn 'helps out' the beetle by blocking the resin ducts in the tree, thus preventing the tree from fighting off a beetle invasion.*

10) What symptom on the outside of the tree indicates that it may be colonized by mountain pine beetle?
   a) Beetles swarming on the outside of the tree.
   b) Pitch tubes (sap dripping) and sawdust at the bottom of the tree.
   c) Blue trees from the blue stain fungus that travels on the beetle.

11) Mountain pine beetles have had a tough time moving into Alberta because:
   a) The cold Alberta winters usually kill them and the Rocky Mountains are a natural barrier to their movements.
   b) They can't decide where to go.
   c) There are more woodpeckers in Alberta to eat them.

12) Climate change could result in:
   a) It raining cats and dogs
   b) An increased number of severe weather events
   c) An expansion of the boreal forest into the prairies

13) Historically, where in Alberta has there been an epidemic mountain pine beetle population?
   a) Jasper National Park
   b) Crowsnest Pass*
   c) There has never been an epidemic in Alberta.
   ** This epidemic began in the late '70s and carried into the '80s*

14) Alberta's coniferous (needle-leaved) forests have been affected by the following:
   a) Historical burning by Aboriginal people
   b) Dutch elm disease
   c) Development of irrigation canals

15) Mountain pine beetle is also found in which of the following U.S. States:
   a) Hawaii
   b) Alaska
   c) Oregon*
   ** Its range is from the Pacific Coast east to the Black Hills in South Dakota, up to northern BC/western Alberta, and down as far south as northwestern Mexico.*

16) What is one human control method used to manage the mountain pine beetle:
   a) Cut down colonized trees and burn them
   b) Catch-and-release them into the United States
   c) Breed extra woodpeckers and release them into mountain pine beetle infected areas

17) The term we use to describe a major mountain pine beetle outbreak is:
   a) An unfortunate event
   b) An epidemic
   c) An endemic attack

18) The main reason we fear the spread of the mountain pine beetle in Alberta is:
   a) It will provide woodpeckers with too much food and they will get fat.
   b) Our pine forests are old and the beetles could spread quickly, killing large areas within a year
   c) It will take over areas that other types of beetles inhabit.

Bonus Question:
The current mountain pine beetle situation is not very important.
   a) No. Actually, it is quite important from an environmental, economic, and social perspective.
   b) All of the above.
   c) Choose a.

Mountain Pine Beetle Activities

Parks Canada Online Lessons
www.pc.gc.ca
(Click on *Teacher's Corner* for access to resources.)

Envirokids Investigate Forest Health
www3.gov.ab.ca/srd/forests/health/p_posters.html

Mountain Pine Beetle Information Websites

Government/Public Information
www3.gov.ab.ca/srd/forests/health/index.html
http://nofc.cfs.nrcan.gc.ca/
www.pfc.forestry.ca/entomology/mpb/index_e.html
www.pc.gc.ca/docs/v-g/dpp-mpb/index_e.asp (English)
www.pc.gc.ca/docs/v-g/dpp-mpb/index_f.asp (French)
www.for.gov.bc.ca/hfp/mountain_pine_beetle/
http://na.fs.fed.us/pubs/fidl_hp.shtm
www.forestlearn.org/watershed/e_health.htm
www.bettyhinton.ca/speeches.asp
www.env.gov.bc.ca/bcparks/ (click on MPB section)

Private/Industry Information
http://ts.tdb.bc.ca/mpb_index.asp
www.westfraser.com/hintonforestry

Non-Government Organization Information
www.davidsuzuki.org/Forests/Canada/BC/Beetle/
www.sierraclub.ca/bc/programs/wildlands/index.shtml

Images
www.forestryimages.org

Mountain Pine Beetle Strategic Direction Council General Contact Information

Parks Canada
Banff National Park
Phone: (403) 762-1500
Email: information@pc.gc.ca
Web: www.pc.gc.ca/docs/v-g/dpp-mpb/index_e.asp (English)
www.pc.gc.ca/docs/v-g/dpp-mpb/index_f.asp (French)

Natural Resources Canada
Canadian Forest Service
Northern Forestry Centre
Phone: (780) 435-7210
Email: inquiries@nofc.cfs.nrcan.gc.ca
Web: nofc.cfs.nrcan.gc.ca

Alberta Sustainable Resource Development
Forest Health Section
Phone: (780) 944-0313 (information centre)
Email: fh.info@gov.ab.ca
Web: www3.gov.ab.ca/srd/forests/health/mpb.html

Alberta Community Development
Parks and Protected Areas
Information Line: 1-866-427-3582 (Toll Free)
Email: Comdev.Communications@gov.ab.ca
Web: www.cd.gov.ab.ca/preserving/

West Fraser Mills Ltd.
Phone: 1-800-293-6955 (Toll Free)
Email: hwpwoodlands@westfraser.com
Web: www.westfraser.com

Spray Lake Sawmills
Phone: (403) 932-2234
Email: woodlands@spraylakesawmills.com
Web: www.spraylakesawmills.com

These websites were accurate at time of printing.

Mountain Pine Beetle