The Impact of Climate Change on the Mountain Pine Beetle and Westerns Forests

Region: Western Mountains and Forests

Grade Level(s): 5-8

Time Required: 2-3 class periods

Focus Question(s):

- How have climate changes impacted the mountain pine beetle (bark beetle) populations in Western Forests and Mountains?
- As the bark beetle populations are affected, how will they, in turn, impact climate?
- What may be the eventual outcome if the present situation continues?

Learning Objectives:

- Students will be able to explain how changing climate may impact organisms and ecosystems.
- Students will understand that the bark beetle, though harmful to forests, has existed in manageable numbers in the past, and that climate impacts have caused unmanageable growth.
- Students will understand that changing the balance of an ecosystem produces changes in the availability of food and shelter, can increase uncertainty for communities of living things and can impact the occurrence of fires and other natural hazards.
- Students will investigate possible solutions for managing the bark beetle infestation for healthier forests.

Prerequisite Knowledge:

- Students should understand the concept of succession (i.e. a change or sequence of vegetation on a given site through time following disturbance of a forest – see USDA Forest Service paper in the Additional Resources section).
- Students should have a general knowledge about trees and forest ecosystems (i.e. producers, consumers, tree biology).
- Students should have studied the carbon, oxygen and water cycles. (A good resource is KidsGeo.com, see Internet Resources)
- Students should have a general background of what climate change is and current climate change research.
- Students should have group work and presentation skills.

Procedures/Instructional Strategies:

1. Set the stage by having students read the following article “Beetle Infestation May Impact Climate Change” (see Internet Resources).

2. In small groups, have students answer the discussion questions, (see Beetle Infestation Activity Sheet and Answer Key) and then have each group share their answers with whole class and discuss.

3. Watch the video clip "The Incident Commander, Clint Kyhl, talks about the Bark Beetle" (courtesy of Wyoming Public Television) from the U.S. Forest Service web site. (see Internet Resources)

    a. Ask students to define what Kyhl means by a "Perfect Storm." (see transcript for answers)

4. After students complete 1-3 above, use the Western Forests and Mountains Case Study as teacher background to help guide a discussion with the class about what the potential or actual impacts of climate change are on the forests and beetle.

5. Continuing to work in their small groups, have students read and discuss the important points in "Mountain Pine Beetle Forest Insect & Disease Leaflet 2" and "Western U.S. Bark Beetles and Climate Change" (see Internet Resources). After reading the articles, have each group present the 4-6 most important points of the articles to the class.

Outcome/Assessment:

- Students, working in small groups, should be able to synthesize the small group, whole class discussions and articles and video clip to make a short 2-5 minute presentation with a poster that explains the Bark Beetle epidemic and possible management solutions.

Extensions/Adaptations:

- Discuss what other measures/data that may be used to investigate the effect of climate on forests and beetles.
- Have students research other environmental factors that impact forests survival, such as fires, logging and erosion, and recreation and human development. Ask students how the addition of climate changes may impact the effects of these other factors.
- Rather than working in small groups where all groups have read all articles and viewed all videos, teacher may want to assign one of the three articles and the video clip to individual groups, then have each group report out to the whole class on their particular findings.
- The Additional Resource "Mountain Pine Beetle Mania" has 6-7 more lessons/activities that may be used to go in to much greater detail on this topic if time permits, and provides all needed student resources and handouts.

Internet Resources Needed for Lessons:

- Kidsgeo.com - background on basics such as Carbon, Oxygen and Hydrology Cycles. http://www.kidsgeo.com/geography-for-kids/0160-the-oxygen-cycle.php ; http://www.kidsgeo.com/geography-for-kids/0159-the-carbon-cycle.php

- Newshour Article, "Beetle Infestation May Impact Climate Change" http://www.pbs.org/newshour/extra/features/health/jan-june08/beetle_4-28.html

- Video Clip of Forest Service Incident Commander

http://www.fs.fed.us/r2/bark-beetle/

- Transcript of Video Clip
  http://www.fs.fed.us/r2/bark-beetle/wyomingbugs.pdf

- Mountain Pine Beetle Forest Insect & Disease Leaflet 2, Reprinted 1990
  Gene D. Amman1, Mark D. McGregor2, and Robert E. Dolph, Jr.3
  http://www.fs.fed.us/r6/nr/fid/fidls/fidl2.htm

- "Western U.S. Bark Beetles and Climate Change" from:
  http://www.fs.fed.us/ccrc/topics/bark-beetles.shtml

- Newshour Article Discussion Questions Worksheet
  http://www-tc.pbs.org/newshour/extra/teachers/lessonplans/health/jan-june08/beetle_4-28_printout.pdf

- Newshour Discussion Questions Answer Key
  http://www-tc.pbs.org/newshour/extra/teachers/lessonplans/health/jan-june08/beetle_4-28.pdf

Additional Resources:

- Brief description of succession from USDA Forest Service:
  http://www.fs.fed.us/rm/pubs/rmrs_gtr023/rmrs_gtr023_005_009.pdf

- "Mountain Pine Beetle Mania"; A complete unit with several lessons from Canada
  http://www.fs.fed.us/r2/bark-beetle/mpbcanada.pdf

- Historical Data on Mountain Pine Beetle Outbreaks, Management Strategies and more information from USDA Forest Service
  http://www.usu.edu/beetle/research_bark_beetle.htm
  http://www.usu.edu/beetle/databases_bark_beetle.htm

- General Climate Change Background for teacher and/or students from CIG/UW
  http://www.cses.washington.edu/cig/pnwc/cc.shtml

National Science Education Standards Addressed:

Life Science:

- The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition. Given adequate biotic and abiotic resources and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.

- An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species' evolutionary history.

- Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some micro-organisms are producers--they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms.

- Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.

- Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the earth no longer exist.

Earth Science:

- Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

- Living organisms have played many roles in the earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.

Physical Science:

- The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation

Beetle Infestation Activity Sheet

Reading Comprehension Questions:

1. How are pine beetles destroying forests in Western Canada? How large is their impact?

2. What is a carbon sink?

3. What role has climate change had in creating the beetle problem?

4. What estimated impact will the pine beetles have on carbon emissions? How does this compare to human activity?

5. What solution to the beetle problem is attractive to the logging industry? Why? What do critics say about this idea?

6. Why might the pine beetle population collapse?

Beetle Infestation Activity Sheet Answer Key

Reading Comprehension Questions:

7. How are pine beetles destroying forests in Western Canada? How large is their impact?

   Answer: The pine beetle, *Dendroctonus ponderosae*, destroys forests by laying eggs under the bark of mature lodge pole pines and jack pine trees. The hungry larvae of the tiny black beetles kill the trees by destroying their ability to take in water and nutrients. Once an infestation starts, the trees cannot be saved and as they rot and die they release, rather than absorb, carbon dioxide. So far, pine beetles have destroyed more than 50,000 square miles of forest in Western Canada and damaged hundreds of thousands of U.S. forests, turning green forests a reddish brown color.

8. What is a carbon sink?

   Answer: Usually, a healthy forest acts as an absorber of carbon dioxide. Scientists refer to this phenomenon as a carbon sink – a place like a forest, ocean or other system that absorbs climate warming CO2. "Historically about 50 percent of the carbon that is released from the burning of fossil fuels has been taken up by terrestrial systems and oceans, allowing only about half of what we burn for fossil fuels to accumulate in the atmosphere," Werner Kurz, co-author of a study of the beetle's impact in the journal Nature, told The Canadian Press.

9. What role has climate change had in creating the beetle problem?

   Answer: According to researchers, the milder winters that have come as a result of climate change have allowed the pine beetle to spread northward and to higher elevations. It takes five days of extremely cold temperatures of about minus 30 degrees Fahrenheit to kill the beetles. Recent winters have been mild and have not produced prolonged periods of extreme cold.

10. What estimated impact will the pine beetles have on carbon emissions? How does this compare to human activity?

    Answer: Researchers created a computer model to estimate the damage that the beetles could do, as well as measure the beetles' future negative impact on Canadian energy-saving efforts to reduce carbon emissions. Canadian scientists estimate that the cumulative impact of the beetle outbreak in the affected region during 2000 to 2020 will be 270 megatons of carbon. Human activity in Canada released the equivalent of 747 megatons of carbon dioxide into the atmosphere in 2005.

11. What solution to the beetle problem is attractive to the logging industry? Why? What do critics say about this idea?

    Answer: The Canadian government is considering possible solutions, including

removing the impacted trees before they rot and release more carbon dioxide. This solution is supported by the logging industry, although the wood is tainted blue by a fungus carried by the beetles and must be sold at a cheaper price than untainted lumber. But other scientists, such as Art Fredeen of the University of Northern British Columbia, believe that salvage logging disturbs plant life on the forest floor, further increasing carbon emissions. "You have all of the shrubs, the moss, lichen; you have a lot of photosynthetic surface that's unperturbed by the mountain pine beetle," Fredeen told Nature News. "When you clear cut, of course, all of that is removed."

12. Why might the pine beetle population collapse?

Answer: Although Canada will have to deal with the impact of a smaller carbon sink for decades to come, the worst may be over. The pine beetle can only reproduce in the largest trees, and soon 90 percent of those will be gone. "The beetle will eat itself out of house and home and the population will eventually collapse," Kurz said.