

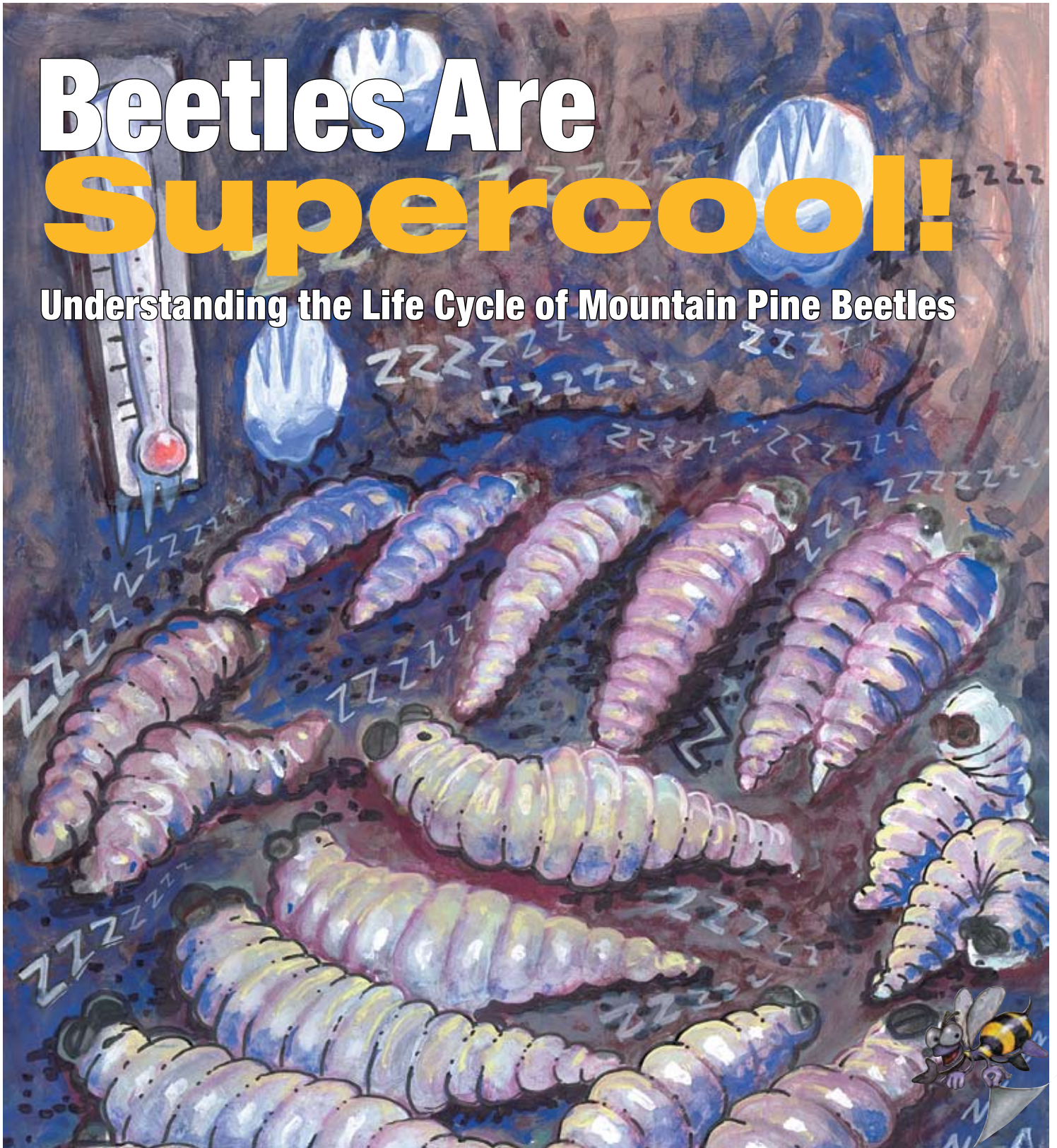
NATURAL

CLIMATE CHANGE EDUCATION COLLECTION • FALL 2008

INQUIRER

Beetles Are Supercool!

Understanding the Life Cycle of Mountain Pine Beetles



Natural Inquirer

Climate Change Education Collection • Fall 2008

Beetles Are Supercool!

Understanding the Life Cycle
of Mountain Pine Beetles

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Education, and Extension
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Washington, DC



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The *Natural Inquirer* is reproduced on recycled paper with soy-based inks.
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About the *Natural Inquirer*

Scientists usually report their research using a standard written form, called a scientific article. When a collection of articles are published together, the booklet is called a science journal. When a single article is published, the booklet is called a monograph. This *Natural Inquirer* is a monograph and includes one scientific article. This monograph was created so that scientists can share their research with you and with other middle school students. The monograph tells you about scientific research conducted by scientists in the Forest Service. If you want to know more about the Forest Service, you can read about it on the inside back cover of this monograph, or you can visit the *Natural Inquirer* Web site at <http://www.naturalinquirer.org>.

All of the research in the *Natural Inquirer* is concerned with nature, such as trees, forests, animals, insects, outdoor activities, and water. First, you will “meet the scientist” who conducted the research. Next, you will read something special about science and about the natural environment. You will also read about a specific research project investigating climate change. Then, YOU become the scientist when you conduct the FACTivity associated with the article. Don’t forget to look at the glossary and the special sections highlighted in each article. These sections give you extra information.

At the end of each section of the article, you will find a few questions to help you think about what you have read. The questions should help you to think more about the research. Your teacher may use these questions in a class discussion.



Welcome to the *Natural Inquirer* Climate Change Education Collection!

As a global citizen, you know that people around the world share similar environmental concerns. The changing climate is one concern shared by people everywhere. Some Forest Service scientists are interested in studying climate change and its relationship to forests, grasslands, air, and water. You will learn about one of these studies in this monograph.

As you know, scientific research is a continual process of discovery. Forest Service scientists are learning much about climate change, but there is still much we do not know.

This monograph is part of a collection of articles describing climate change research. You can order any of the *Natural Inquirer* monographs or journals by visiting <http://www.naturalinquirer.org>. The monographs and journals are free of charge.

Educators: Review “Note to Educators” on page 10 before using this *Natural Inquirer* monograph.

<http://www.naturalinquirer.org>





Beetles Are Supercool!

Understanding the Life Cycle of Mountain Pine Beetles

Meet Dr. Jesse Logan:

I like being a scientist because of the excitement of learning new things and the rewards of being creative. I became interested in natural resources as a young boy enjoying the out-of-doors in the Rocky Mountains.



Meet Dr. Barbara Bentz:

I like being a scientist because I enjoy the art of discovery. I became interested in natural resources when I was a young child, traveling and camping with my family.



Thinking About Science

Many plants and animals live in *annual* cycles. They respond to seasonal temperature changes and changes in the length of the day. Some scientists are interested in studying the effect of these seasonal changes on the life cycle of plants and animals. The science that investigates these effects is called *phenology* (fe näl uh jē). The science of phenology also investigates the influence of *climate* on the life cycle of plants and animals. This is important, because many scientists now believe that our climate is changing. In this study, the scientists were interested in understanding how a change in climate might affect the life cycle of a particular species of beetle. Because they

Glossary:

annual (an yoo ul): Covering the period of 1 year.

climate (kli met): The average condition of the weather at a place.

larva (lär vuh): Wormlike feeding form that hatches from the egg of many insects.

metabolize (muh ta buh liz): Chemical changes in a living body that provide energy to the cells for survival, growth, and reproduction.

carbohydrate (kär bō hi drat): Starches and sugars that are used as food by animals.

phloem (flo em): Tissue that transports nutrients from the leaves to the rest of the plant.

pupa (pyoo puh): Intermediate stage of insect growth between larva and adult.

resin (rez in): Cloudy, sticky substance that oozes from some trees.

population (pop yoo la shun): The whole number of individuals of the same type occupying an area.

stand (stand): A group of trees growing in a continuous area.

complexity (käl m plek suh tē): The state of being complicated or having many related parts.

simulate (sim yoo lat): To create the appearance or effect of something for purposes of evaluation.

indicator species (in di kat ür spe sez): Type of plant or animal that serves as a measure of the environmental health of an area.

Pronunciation Guide

ā	as in ape	ô	as in for
ä	as in car	ü	as in use
e	as in me	û	as in fur
i	as in ice	oo	as in tool
o	as in go	ng	as in sing

could not wait a hundred or more years for the climate to change, the scientists used a computer program to predict what might happen.



Thinking About the Environment

Mountain pine beetles (*Dendroctonus ponderosae* Hopkins) are sometimes supercool! This is what scientists call the beetles' ability to "chill out" during the cold winter months, during their *larva* stage (Figure 1). During the winter, the beetle larvae live in the interior of pine trees. Because mountain pine beetles are composed partly of water, they must have made adaptations to keep from freezing in the cold of winter. When water freezes, it forms six-sided crystals. The crystals have sharp edges that could damage the other structures inside of the beetle. Mountain pine larvae have found a way to *metabolize carbohydrates*, which contain water, into glycerol (glis ūr

ol) during the winter months. Glycerol is a form of alcohol, and therefore will not freeze – it is insect antifreeze! When the temperatures turn warm again, the larvae turn the glycerol back into carbohydrates. Carbohydrates are a source of energy for the beetles. Mountain pine beetles have adapted to cold conditions, and this allows them to survive.

Introduction

Mountain pine beetles live for only 1 year. Most of the year is spent "chilling out" in a condition scientists call supercool. Because they live in high mountain environments where it is very cold, they spend most of their short life span being supercool. That does not give them much time to lay eggs and reproduce. When these beetles reproduce, they lay eggs in the *phloem* of pine trees (Figure 2). These eggs become the larvae that live in the phloem during the cold months. In late summer, *pupa* become adults and emerge from the pine trees. As

adults, the beetles must bore holes in other pine trees so they can lay their eggs. When they bore holes in the trees and lay eggs, the beetles usually kill the tree. Pine trees produce *resin* to repel the beetles. To successfully lay their eggs, the beetles must work as a team. They bore holes in pine trees in large numbers (Figure 3). When you think about it, you can see that the *population* of mountain pine beetles needs to coordinate its activities. If each individual beetle did these things on its own schedule, the species would not survive.

Mountain pine beetles are part of an ecosystem. When beetles kill a *stand* of weakened trees, natural fire may follow. When fire burns the trees that have been killed by the beetles, the area becomes favorable for new trees to grow. This helps the forest to renew itself. On the other hand, when beetles kill a stand of trees, there are fewer trees that can be used for wood products for human needs.

Remember that mountain pine beetles are dependent on warm weather to reproduce, and they only have part of one summer to lay their eggs before dying. If the climate changes in the future, how will the beetles adjust? The scientists in this study wanted to explore how mountain pine beetles detect when it is time to emerge from pine trees. This information would help the scientists to predict what might happen to the beetles if the climate changes in the future.

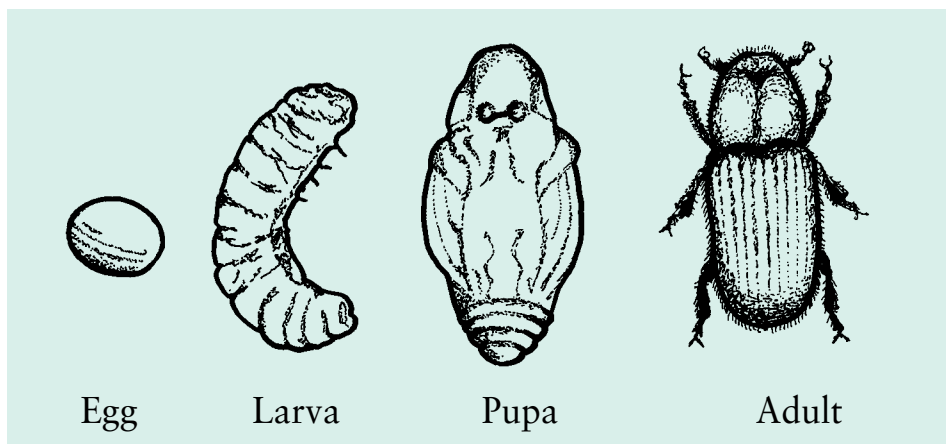


Figure 1. The life stages of the mountain pine beetle, including egg, larva, pupa, and adult.

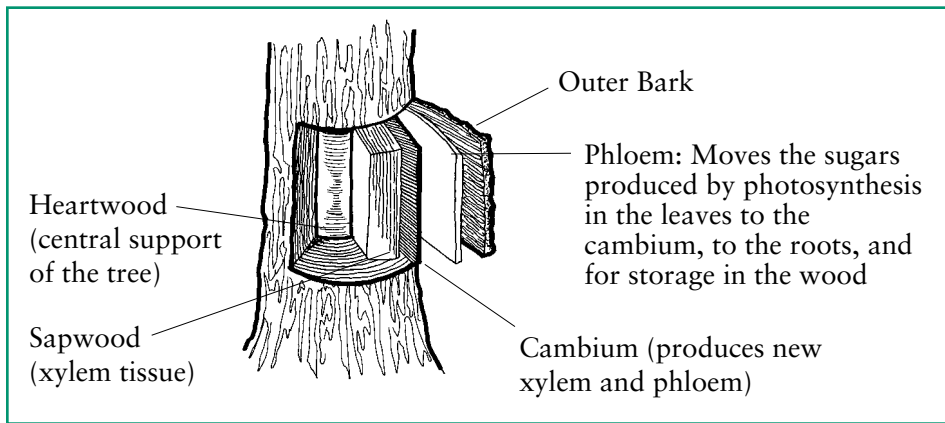


Figure 2. Mountain pine beetles spend much of their life in the phloem of pine trees.

Methods

To understand the scientists' methods, you will have to think about the *complexity* of the beetles' life cycle. Thousands of adults must emerge from pine trees at the same time in the late summer. They must emerge after all danger of frost is gone. They cannot wait too long past that date, because they only have a short time to lay eggs before they die in the fall or winter. All of them must bore holes into the pine trees at the same time, or the pine trees will successfully repel them with resin. The scientists needed to know the temperature for the whole life cycle of the beetles (How many days is that? – Hint: Re-read the first sentence of the Introduction.) The scientists used measurements of the temperature that were made every hour of every day for a year. (How many measurements did they use?) They used measurements for 4 different years. (Now multiply the number of measurements by four – how many measurements did they use?)

The scientists already knew a lot about the beetles' life cycle. Using a computer program that contained all of the temperature measurements, they guessed what would happen to a beetle if it emerged from a tree's interior on every day of the year. Using the computer program, they were able to identify which days would be the best ones for the beetles to emerge. Then, they added 2.5 °C to each of the



Reflection Section

- Think about the variation in springtime temperatures.

How do scientists know that the first very warm day is not the signal used by the beetles to emerge from the trees? What would happen to the beetles if they emerged from the tree on the first warm day?

- When an ecosystem is balanced, it is healthy. A bal-

anced ecosystem means that everything depends on everything else, and no one plant or animal takes over the rest. The pine beetle/pine tree ecosystem is usually balanced between the beetles and the pine trees. This is because the beetles select the weakest trees in which to lay their eggs. Then, the weaker trees die and make room for new, healthier trees. In what ways could the pine beetle/pine tree ecosystem become unbalanced?



Figure 3. A stand of pine trees killed by mountain pine beetles.

temperature measurements. They did this to *simulate* what might happen when the climate changes in the future, since the general trend is for the Earth to be getting warmer.



Reflection Section

- What are the advantages of using a computer program to simulate the emergence of the beetles? Could the scientists have done the calculations by hand? Why or why not?
- What do you think will happen to the beetle population if the temperature rises by 2.5 °C?

Findings

The scientists found that temperature was the most important factor affecting the emergence of beetles from pine trees. The scientists predicted that if global warming occurs (represented by the addition of 2.5 °C to the temperatures), mountain pine beetles could move farther north and into higher mountains. This means that their range could expand. The scientists also predicted that if mountain pine beetles live in warmer climates, they may produce a larger number of eggs. Changes in temperature could also change the timing of their life cycle. The beetles would probably not always emerge from the trees at the

same time. Unfortunately for the beetles, this would mean that the teamwork they use to lay their eggs in pine trees would not be as strong.



Reflection Section

- If global change creates warmer temperatures in the future, what do you think might happen to the population of mountain pine beetles? Why?
- If the population of mountain pine beetles begins to increase, what might happen to the population of pine trees? Could any changes be balanced by the lack of beetle teamwork? Why or why not?

Discussion

It is clear that global climate change would cause a change in the ecosystem that includes mountain pine beetles and pine trees. The scientists believe that studying mountain pine beetles may help people understand if and how the global climate is changing. If populations of beetles living in high mountain environments are monitored, any change in their patterns of emergence, egg laying, or range might indicate a change in climate. The scientists believe that the mountain pine beetle is a good *indicator species* for environmental change.



Reflection Section

- From what you have observed and learned from school, newspapers, and other places, do you think the global climate is changing? Why or why not?
- What other ways might global climate change be monitored?
- What can humans do to reduce the possibility of global climate change?



FACTivity

Did you know that beetles are one of the most numerous types of life forms on Earth? Beetles live everywhere across the Earth, except in the open ocean. And, beetles are even older than the dinosaurs! To be so successful, beetles have many advantages that help them survive. In this FACTivity, we are going to get to know beetles close up! Get a bug box (a clear plastic box with plenty of room for air). Look outside in your school yard or at home for beetles. Find a beetle, and gently put it in the bug box. After you observe the beetle, you should release it back outside, in the same place where it was found.

We will examine three parts of the beetle: the back legs, the wings, and the mouth. See

When Scoring Zero Wins

As the pine beetle research shows, climate change will change conditions for the living creatures of the Earth. One way to slow climate change is to reduce the production of carbon dioxide, or CO₂. Carbon dioxide is produced by cars, buses, and any other thing that burns fossil fuels. The Olympic Winter Games of 2002, or any event

with many people, requires a lot of vehicles. Can you guess what that means? Right! Lots of carbon dioxide! Planners of the 2002 Games wanted to find a way to keep carbon dioxide emissions from the 2002 Games at zero. It sounds impossible, doesn't it? This is how they did it. Along with using the latest in emissions-reducing technologies, they

asked large companies and individuals to reduce their energy consumption equal to the amount the Olympic Winter Games of 2002 would produce.



the illustrations below and compare them with the beetle you are observing. Let's start with the back legs. Can you see how they are constructed? What do you think the beetle does with its back legs? Beetle legs are designed for digging into wood or soil. Which do you think this beetle digs into? Now look at the wings. Beetles have two sets of wings. The back wings are similar to those of many other flying insects. You may not be able to see the back wings when the beetle is not flying. The most unusual thing about a beetle is its front wings. They

are hard, and when folded create a hard shell around the beetle's body. Can you see the hard front wings? What purpose could the hard wings serve? (Hint: Think about what the beetle has to do to get its food or lay its eggs.) Finally, look at the beetle's mouth. A beetle's mouth is made for chewing. Other things that a beetle can do with its mouth are grasp, tear, and crush. Think about the mountain pine beetle. You can see that it is well designed to dig into the bark and phloem of trees.

Now, get a large piece of paper and draw the beetle you are observing. Use crayons to complete the drawing. You may want to focus your drawing on one of the three parts that we examined below. When you have finished drawing the beetle, don't forget to release it back into the same place where you found it!

FACTivity adapted from: Hogan, K. (1994). *Eco-Inquiry: A guide to ecological learning experiences for the upper/elementary/middle grades*. Dubuque, Iowa: Kendall/Hunt. 1-800-228-0810. Reprinted with permission.

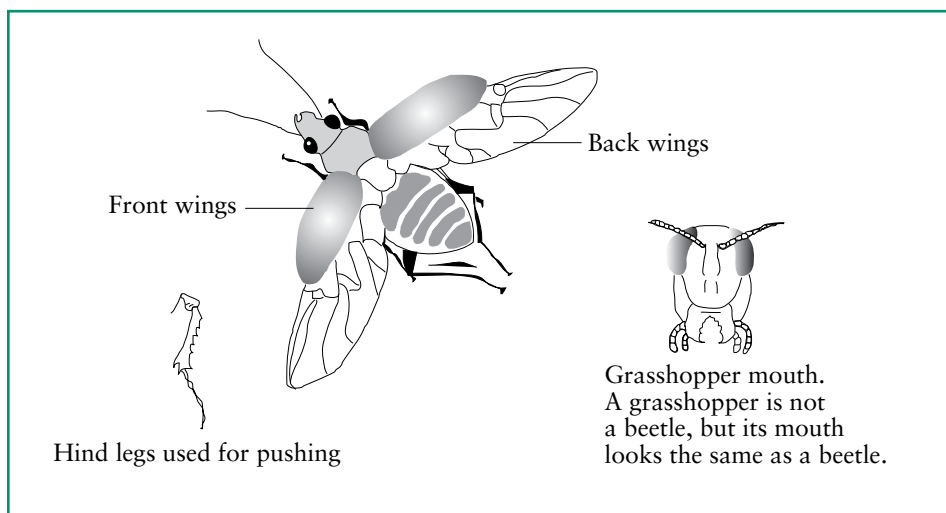
From Logan, Jesse A. and Bentz, Barbara J. (1999). Model analysis of mountain pine beetle (Coleoptera: Scolytidae) seasonality. *Environmental Entomology*, 28(6): 924-932.

From Bentz, Barbara J. and Mullins, Don E. (1999). Ecology of mountain pine beetle (Coleoptera: Scolytidae) cold hardening in the Intermountain West. *Environmental Entomology*, 28(4): 577-587.

Thank you to Dr. Dan Miller, USDA Forest Service, Southern Research Station, for helping us to understand that mountain pine beetles are sometimes supercool!

Websites:

<http://www.usu.edu/~beetle/>



Note to Educators

The mission of the Forest Service is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. For more than 100 years, our motto has been caring for the land and serving people. We recognize our responsibility to be engaged in efforts to connect youth to nature and to promote the development of science-based conservation education programs and materials nationwide. We have developed the *Natural Inquirer* Climate Change Education Collection to help you and your students better understand climate change.

Forest Service researchers have studied the impacts of climate change and air pollutants on forests and grasslands for more than 30 years. This research has identified climate change trends and subsequent effects to ecosystems across the United States and worldwide. For their research contributions to the Intergovernmental Panel on Climate Change (IPCC) Report, 13 Forest Service scientists were recipients of the Nobel Peace Prize in 2007. The Nobel Committee recognized "efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change."

The articles in the Climate Change Education Collection will introduce students to several of these scientists and their climate-change-related research. Students will learn about the scientific process used by the scientists and will be engaged in hands-on activities on climate change topics such as the carbon cycle, invasive species, vegetation changes, and urban and world forests.

As teachers of science, you want your students to acquire abilities that will enable them

to conduct scientific inquiry, and you want them to gain an understanding of the scientific inquiry process. Scientific inquiry can best be taught by integrating minds-on and hands-on experiences. Over time, such experiences encourage students to independently formulate and seek answers to questions about the world we live in. As educators, you are constantly faced with engaging your students in scientific inquiry in new and different ways. In an age of abundant technology, standard teaching strategies can become monotonous to today's learners. The *Natural Inquirer* provides a fresh approach to science and a view of the outside world that is larger than the classroom and can still be used while in the school setting.

The *Natural Inquirer* is a science education resource journal to be used with learners from Grade 5 and up. The *Natural Inquirer* contains articles describing environmental and natural resource research conducted by the Forest Service, U.S. Department of Agriculture scientists and their cooperators. These are scientific journal articles that have been reformatted to meet the needs of middle school students. The articles are easy to understand, aesthetically pleasing to the eye, contain glossaries, and include hands-on activities. The goal of the *Natural Inquirer* is to stimulate critical reading and thinking about scientific inquiry and investigation while learning about ecology, the natural environment, and natural resources.

The format of a *Natural Inquirer* article: Each *Natural Inquirer* article follows the same format. *Natural Inquirer* articles are written directly from a published science article, and all have been reviewed by the scientists for accuracy. Each article contains the following

sections, which you may introduce to your students as they read:

Meet the Scientists: Introduces students to the scientists who did the research. This section may be used in a discussion of careers in science.

Glossary: Introduces possibly new scientific or other terms to students. The first occurrence of a glossary word is italicized in the text.

Thinking About Science: Introduces something new about the scientific process, such as a scientific habit of mind or procedures used in scientific studies.

Thinking About the Environment: Introduces the environmental topic being addressed in the research.

Introduction: Introduces the problem or question being addressed by the research.

Method: Describes the method used by the scientists to collect and analyze their data.

Findings: Describes the results of the analysis.

Discussion: Discusses the findings and places them into the context of the original problem or question.

Citation: Gives the original article citation.

FACTivity: Reinforces an aspect of the research through a hands-on activity.

Science Education Standards and Evaluations: In the back of the monograph,

you will find a list that allows you to identify articles by the National Science Education Standards they address. You and your students may also complete evaluation forms online by visiting <http://www.naturalinquirer.org>. If you have any questions or comments, please contact:

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(Please put “Educator Feedback” in the subject line)

Educator Resources:

From the Web site, you can read and download lesson plans, word games, and other resources to help you use the *Natural Inquirer* in your classroom. You can also view and download a year-long lesson plan aimed at helping your students learn about the scientific process.

Visit the *Natural Inquirer* Web site at <http://www.naturalinquirer.org>

For more climate change information, visit: <http://www.fs.fed.us/climatechange/>

Lesson Plan for This Monograph

Time Needed:

One class period (50-60 minutes)

Materials Needed:

- 1 piece of plain white 8.5 X 11” paper for each student; 1 piece of plain paper for each group of 4 students
- 3 X 5” sticky notes (enough for at least 7 per student)

In class the day before:

Give each student a copy of the monograph, a piece of plain paper, and three sticky notes. The sticky notes should be placed on the paper and labeled “Science,” “Environment,” and “Prediction.”

For homework:

Ask them to read “Thinking About Science” and “Thinking About the Environment.” After they read each section, have them write the main idea of the section on the correct sticky note. On the third sticky note, they should predict what they think the article will address. Ask them not to read ahead in the monograph, but to use clues from the two sections to help them predict. They should also review the glossary before coming to class.

In class:

Introduce the *Natural Inquirer* monograph to the class. Include information about the sections they will be reading. (See “Note to Educator, The Format of a *Natural Inquirer* Article” on page 10.) (5 minutes)

On your whiteboard or clean chalkboard, label three areas “Science,” “Environment,” and “Prediction.” Have each student place his or her sticky note in the correct area. Have a few students read some of the notes, one section at a

time. Hold a class discussion about the similarities and differences of the notes in each section. Have students identify what clues they used to predict what the article would address and how the scientists might address it. (8 minutes)

Read “Meet the Scientists,” “Introduction,” “Methods,” “Findings,” and “Discussion” Sections as a class. When you reach the end of each section, have students write the main idea of the section on a labeled sticky note. For now, skip the reflection questions. When the article has been completely read and all sticky notes completed, have students place their sticky notes on the whiteboard, under the correct heading (Introduction, Methods, Findings, Discussion). (18 minutes)

Now, have each student select one sticky note from each category. They must not select their own sticky note. Place students in groups of four. Each group should compare and contrast their sticky notes for each section. On a sheet of paper, one student will write the four headings and under each heading, write the main ideas of each section as agreed on by the group. Each section’s main ideas should be between 1 to 4 sentences long. (5 minutes)

Have each group read its main ideas for one or more sections (based on available time). Hold a class discussion to compare and contrast what each student group reported. (5 minutes)

Hold a class discussion about the research they have just read. What might happen to the environment in the future, given what they have learned? (5 minutes)

Make a list of actions they can take to reduce their carbon footprint (4 minutes). Examples include:

- Walk and bike more, ride in a car less.
- Eat more local produce; buy from local farmers' markets.
- Plant and maintain trees.
- Turn down the thermostat by 1-2 degrees in the winter.
- Turn up the thermostat by 1-2 degrees in the summer.
- Turn off appliances when not in use.
- Turn down the temperature in the hot water heater.
- Unplug your phones, etc., as soon as they have charged.
- Only do full loads in the dishwasher and clothes washer.
- Hang out clothes to dry.
- Consolidate car trips.
- Use energy-efficient light bulbs.
- Take shorter showers.

Day 2 (Optional): Do the FACTivity.

Lesson Plan Extension (This can be done in place of the FACTivity or as an extension on Day 3 if time allows.)

For homework, have students complete the reflection questions. They can use the same “sticky note” process to record their answers. In class on Day 2 (or 3, if you have done the FACTivity on Day 2), discuss their answers as a class. You may use the whiteboard to “mix up” the answers in the same manner as Day 1.

Reflection Section Answer Guide

Introduction

- **Think about the variation in springtime temperatures. How do scientists know that the first *very* warm day is the signal used by the beetles to emerge from the trees? Scientists have observed the beetles emerging from pine trees in late summer to lay eggs and reproduce. What would happen to the beetles if they emerged from the tree on the first warm day? If the beetles emerge too early, a late frost may kill them, so they wait until it is *very* warm before they emerge from the trees.**
- **When an ecosystem is balanced, it is healthy. A balanced ecosystem means that everything depends on everything else, and no one plant or animal takes over the rest. The pine beetle/pine tree ecosystem is usually balanced between the beetles and the pine trees. This is because the beetles select the weakest trees in which to lay their eggs. Then, the weaker trees die and make room for new, healthier trees. In what ways could the pine beetle/pine tree ecosystem become unbalanced? The ecosystem could become unbalanced if the beetles increased or decreased in population. The beetles could affect too many trees if beetle populations increased. Likewise, if the tree population increased and the beetle population did not change, then the tree population would not be as healthy as when it was balanced. The beetles kill the weak and sick trees in the balanced system, resulting in more nutrients for the healthy trees. Without the beetles, whole populations of trees would be out of balance. If the tree population decreased and the beetles remained unchanged, more trees could be affected, or killed off, by the beetles. A balanced system is very important for a healthy environment.**

Methods

- **What are advantages of using a computer program to simulate the emergence of the beetles? Technology is essential for science because it provides instruments and techniques that enable observations of the emerging beetles that are otherwise unobservable due to quantity, distance, location, size, and speed. (This is a great opportunity to have the students discuss the advantages of technology.) Could the scientists have done the calculations by hand? Why or why not? Scientists COULD have done these calculations by hand; however, the amount of observations makes the calculations impractical. Technology has revolutionized science and enables scientists to study things that would otherwise would have been impractical because of their size.**
- **What do you think will happen to the beetle population if the temperature rises by 2.5°C? Student discussion is very appropriate here. If the temperature rises, this will activate the emergence of the beetles for a longer period of the year. This means that the beetles will be affecting the trees at a different time and increases the amount of time the beetles are active.**

Findings

- **If global change creates warmer temperatures in the future, what do you think might happen to the population of mountain pine beetles? The beetles become active during the warmer periods where they lay eggs and reproduce. Why? If there is a warmer period throughout the year, then beetles will be able to lay eggs and reproduce longer. This could**

lead to a larger population of beetles that could affect more pine trees.

- **If the population of mountain pine beetles begins to increase, what might happen to the population of pine trees?** The pine tree population could decrease quickly because the beetle population kills selected trees to lay eggs in the phloem. With more beetles in the ecosystem, more trees would need to be selected. **Could any changes be balanced by the lack of beetle teamwork? Why or why not?** Remember, pine trees produce resin to repel the beetles; the beetles have to work in teams to successfully lay their eggs. If the beetles lack teamwork, then many may not survive and more trees may survive.

Discussion

- **From what you have observed and learned from school, newspapers, and other places, do you think the global climate is changing? Why or why not?** This question will vary depending on the experience of the students. Having a class discussion will help generate thoughts and ideas.
- **What other ways might global change be monitored?** This question will vary depending on the experience of the students. Having a class discussion will help generate thoughts and ideas. Some ideas include monitoring glaciers, plants, other animals, atmospheric gases, etc., over time.
- **What can humans do to reduce the possibility of global climate change?** This question will vary depending on the experience of the students. Having a class discussion will help generate thoughts and ideas. Some thoughts may include reducing use of fossil fuels, recycling, conserving energy, conserving the environment, and becoming more aware of human impacts.

Beetles Are Supercool!

National Science Education Standards* Addressed With This Monograph:

	BEETLES ARE SUPERCOOL!
Science as inquiry	
Abilities necessary to do scientific inquiry	X
Understandings about scientific inquiry	X
Life Science	
Reproduction & heredity	X
Regulation & behavior	X
Populations & ecosystems	X
Diversity & adaptations of organisms	X
Earth & Space Science	
Structure of the earth system	X
Science & Technology	
Understandings about science & technology	X
Science in personal & social perspective	
Natural hazards	X
Science & technology in society	X
History & nature of science	
Science as a human endeavor	X
Nature of science	X

* National Research Council, Content Standards, Grades 5-8.

What Is the USDA Forest Service?

The Forest Service is a part of the U.S. Department of Agriculture. It is made up of thousands of people who care for the Nation's forest land. The Forest Service manages over 150 national forests and almost 20 national grasslands. These are large areas of trees, streams, and grasslands. National forests are similar in some ways to national parks. Both are public lands, meaning that they are owned by the public and managed for the public's use and benefit. Both national forests and national parks provide clean water, homes for the animals that live in the wild, and places for people to do fun things in the outdoors. National for-

ests also provide resources for people to use, such as trees for lumber, minerals, and plants used for medicines. Some people in the Forest Service are scientists, whose work is presented in the journal. Forest Service scientists work to solve problems and provide new information about natural resources so that we can make sure our natural environment is healthy—now and into the future.



<http://www.fs.fed.us/>

What Is the Cradle of Forestry Interpretive Association?

The Cradle of Forestry Interpretive Association (CFIA) is a nonprofit organization. It was founded in 1972 by a group of conservationists to help the Forest Service tell the story of forest conservation in America. The CFIA helps people better understand forests and the benefits of forest management.



http://www.cradleofforestry.com/interpretive_association/



Editorial Review Board



Every *Natural Inquirer* article is reviewed by middle school science students. Student comments help to continually improve the *Natural Inquirer*. This is Mr. Thomas Williamson's 5th grade class in Kearns, Utah.

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