beetles
Science and Teaching for Field Instructors

Student Activity Guide

Fire Management Discussion

Discussing environmental issues can be a pivotal part of a student's environmental education. Thinking about complex issues while engaging in respectful discussion is an opportunity for students to develop skills that are important throughout life. In this activity, students discuss the question, "Should humans stop wildfires?" At first, students typically respond, "Yes! Fires are bad!" In reality, fire management is a challenging environmental management problem, and the question has no simple answer. To make actual fire policy decisions you need a thorough analysis of the impacts of fires—which are not all bad!—on different ecosystems. You also need to think about the usefulness, cost, and effects of different management approaches and solutions. In *Fire Management Discussion,* students consider the impacts of fires on different types of ecosystems (including the one your site is in), and discuss the merits and drawbacks of possible management strategies. This discussion helps students understand the complexity of all environmental issues and management decisions, while developing critical thinking and discussion skills.

Students will...

- **Think about the possible impacts of a fire in the surrounding ecosystem, and other ecosystems.**
- **Discuss the main question: "Should humans stop wildfires from burning," using their prior knowledge, Evidence Cards, and information from the instructor as evidence.**
- **Evaluate the merits and drawbacks of different possible fire management strategies.**

Grade Level:
Suggested for Grades 5–8

Timing:
20–35 minutes

Related Activities:
Argumentation Routine, Walk & Talk, Turn & Talk, What Lives Here? Most Successful Organism Discussion, Ecosystem Theme Hike

Materials:
Print and cut out the attached "Evidence Cards" on pages 12–13.
Optional: photos of a few different ecosystems.

Tips:
To ensure a successful experience, review the teaching tips found on page 2 and throughout this guide.

Setting:
Anywhere you can circle the group comfortably for a discussion, and if possible, with evidence of a past burn, such as a burnt stump; an area with obviously high fuel load; or an area where you can see some fire prevention strategies in place.

NEXT GENERATION SCIENCE STANDARDS

FEATURED PRACTICE	FEATURED CROSSCUTTING CONCEPT	DISCIPLINARY CORE IDEAS
Arguing from Evidence	Cause and Effect	Natural Hazards

For additional information about NGSS, go to pages 9–11 of this guide.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Fire Management Discussion

ACTIVITY OVERVIEW

Fire Management Discussion	Learning Cycle Stages	Estimated Time
Introducing the Activity	Invitation	5–10 minutes
Engaging in Deeper Discussion	Exploration, Concept Invention, Application	10–18 minutes
Wrapping Up the Discussion	Reflection	5–7 minutes
TOTAL		**20–35 minutes**

TEACHING TIPS

Field Card. On page 13 of this guide is a pocket-sized version of this lesson that you can use in the field.

Read the Instructor Support Section. Beginning on page 7, you'll find more information about pedagogy, student misconceptions, science background, and standards.

Working up to discussion. Before launching into this type of discussion, give your students practice discussing science ideas to establish a culture of discussion within your group. Try some pair talk first, with activities like *Walk & Talk* and *Turn & Talk*, and introduce discussion norms before engaging in this activity. Engage in other "low stakes" discussions about things students find and are intrigued by.

Choose the right moment for the discussion. Lead this discussion at a time when students will be able to be engaged. Don't start the discussion at the beginning of a field experience for the day, or when students clearly have a lot of energy and are excited to explore. Try leading the discussion after students have hiked up a large hill, after students have just spent time running around, or at a moment when they are already engaged in a discussion about impacts on ecosystems and they seem excited to continue.

How to use the Evidence Cards. See the Using Evidence Cards section in Instructor Support on page 7 for different concerns and strategies about how to most effectively use Evidence Cards with a group.

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Introducing the Discussion

1. **Introduce the topic of wildfires.** Explain that the group is going to spend some time thinking and talking about wildfires.

2. **Review discussion norms, and challenge students to learn to be more productive participants in discussion.** Review discussion norms, and as a group, consider choosing one discussion norm to focus on in particular. Challenge students to think about how they normally participate (or don't participate) in discussion, and to pick something they could focus on doing more or doing less during this discussion, to be more productive participants. For example, if they tend to talk a lot during discussions, perhaps they could focus more on asking questions of others. If they don't tend to talk much during discussion, perhaps they could try speaking up more.

3. **Challenge students to be flexible thinkers, to change their minds about something during the activity, and to remember when this happens.** Being open-minded and ready to learn from any situation is a sign of flexible thinking. Explain that the point of a discussion like this is not to "win," but to learn to think about an issue in different ways, and to learn how to be a more productive participant in discussion. Challenge students to find at least one opportunity during the activity to change their minds based on evidence or others' ideas, and to notice when this happens so they can share it later.

4. **Help students access their prior knowledge about wildfires, through a *Think, Pair, Share*.** Ask students to think about what they know about wildfires, and specifically, how these fires start, how they stop, and what causes them to get out of control. Ask:
   - *What do you know about wildfires?*
   - *What do you know about how wildfires start, stop, and what causes them to get out of control?*

5. **Hear a few student responses, ask follow-up questions, and introduce a bit of content about how fires start, spread, and stop.** If students don't share the following information, introduce some, but not all, of it (particularly the parts in italics):
   - Sometimes fires are caused naturally by lightning strikes. *But most of the huge and destructive wildfires of recent times are started by people, by campfires getting out of control, by arson, or even by something as small as a spark from a train track hitting dry grass.*
   - *Fires need heat, oxygen, and fuel to burn and spread. Fires spread faster when it's hot, dry, and windy, whereas wet and cool weather slows them down. Typically, the more dead/dry brush that's present in an ecosystem, the higher the fuel load, and the higher the fire danger.* Fires spread faster when they're headed uphill, because the heat of the fire downhill heats up the fuel uphill.
   - *To stop wildfires, the main strategy is to take away all the fuel (water and fire retardants may also be used to reduce heat, but you can't remove oxygen or change the weather). Firefighters make a "fuel break" by using bulldozers*

TEACHING NOTES

Discussion Norms. If you have already gone over discussion norms with your group, remind students of those norms before sending them off to discuss in small groups. Discussion norms include:
- Listen actively and share ideas
- Share and ask for evidence
- Build on ideas of others
- Keep an open, curious mind
- Disagree respectfully to increase understanding
- Pay attention to participation

Why introduce content now? Having some knowledge of how fires start, spread, and stop will help students make more informed arguments and explanations when comparing different management strategies. Don't introduce all this content, but try to help students understand the basic idea that more fuel means a hotter, faster spreading fire, and the main strategy for stopping a wildfire once it starts is removing the fuel.

TEACHING NOTES

Keep it moving. Hear just a few students' initial thoughts, ideally a few different perspectives, but don't have every student share during this time. Keep the group interested and move on so they continue to engage in the conversation.

and shovels to remove all of the fuel (including all trees, other plants, sticks, or anything flammable) around the edges of a fire, leaving a giant dirt line around the fire. Once the fire burns through all the fuel inside the break, it stops (hopefully).

6. **Introduce the main question to students, and give them a moment to *Turn & Talk* about their initial thoughts.**
   - *Think about this question, then I'll signal when it's time to discuss your ideas with a partner: "Should humans stop wildfires from burning?" (or to phrase it another way, "If a fire started here, in this area, should humans stop it?").*
7. **Hear some student responses, and ask them to share their reasoning.** Let a few students share their initial thoughts and reasoning, and ask the group to show agreement with a signal (such as snapping, or a different signal the group uses).
8. **Summarize the group's initial positions, and tell students they'll think together about the issue from different perspectives, considering different evidence.** For example: "Thanks for sharing those thoughts. It seems like right now most members of the group think humans should stop wildfires because of damage to property and to wildlife, and some think we should let fires burn sometimes if the fires are small. We're going to keep discussing this issue while considering other evidence."

Engaging in Deeper Discussion

1. **Introduce "ecosystem" as the living and non-living things that interact with each other in a particular environment.** If students already know the term, remind them or ask them what it means.
2. **Name the type of ecosystem you are in and ask students to brainstorm different ecosystems.** Listen to their ideas. If they need help, you might mention a few, such as deserts, chaparral, coastal scrub, deciduous forest, grassland, prairie, stream, and different types of forest ecosystems, like temperate evergreen forest, temperate deciduous, pine forest, or redwood forest.
3. **Ask students to think about and discuss how a wildfire might impact the ecosystem around them.** Explain that they've already shared some initial thoughts about whether humans should stop wildfires, and now they'll think about how wildfires impact forests and other ecosystems, specifically the ecosystem they're currently visiting with you. Encourage them to connect their discussion with what they've seen in the ecosystem. For example, they might say, "I think the salamanders we saw are too slow to move away from a fire, so they'd die."
   - *Think about what you've seen of this ecosystem. How might a wildfire impact this ecosystem and what is your evidence?"*
4. **Ask students to look at the surrounding ecosystem and discuss what might be "fuel" for a fire, and whether they think there's more or less of a fuel load than in other ecosystems.** Ask students to think about what might burn around them in a fire, and to think about the fuel load of the

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ecosystem they're in compared to other ecosystems. Consider sharing photos you've printed in advance of other ecosystems, for students to use for comparison.

5. **Ask students to then discuss how fire might impact other ecosystems, hear a few answers, then move on.** Ask:

   ▶ *How might different amounts of fuel in different ecosystems impact how a wildfire behaves in and impacts an ecosystem? Share your evidence and reasoning.*

6. **In no specific sequence, ask students to discuss some (but not all) of the questions below, first in the whole group, then with a small group (with Evidence Cards), and finally in the whole group again.** After each question, ask a few students for their responses. Then, ask for agreement and disagreement, or for students to add to each others' ideas. If students bring up questions, toss them back to the group. Then, ask another question leading back to the topic, or introduce an additional piece of evidence for students to consider.

   - **Whole group.** Lead a whole group discussion using some of the questions.
   - **Small groups with cards.** When it seems students could use more information to inform their explanations or arguments, tell them they're going to break into small groups and get more information on the topic through Evidence Cards, to help make the discussion deeper. Small groups will discuss each piece of evidence, and whether it changes their thinking.
   - **Whole group again.** Ask students to share anything they learned that made them think about the issue in a different way. Include the original question again during this part.

Questions:

a. What are ways wildfires could impact people?

b. Are all people impacted equally by the effects of forest fires? Why or why not?

c. Who do you think should be responsible for deciding how to manage wildfires?

d. There are 3 main strategies for managing fires: moving fuel, starting smaller fires to burn through fuel, and letting fires burn once they have started. Discuss each option, thinking about benefits and drawbacks for each.

e. *Original question again:* Should people stop wildfires once they begin? Why or why not?

f. *[If students say how people should react to fires should depend on the situation.]* In which situations should humans stop fires? In which situations shouldn't they? What are the benefits or drawbacks to each of these approaches?

TEACHING NOTES

Adding evidence or information. Pay attention to what your students share after posing the initial question. If they don't seem to have any ideas beyond "fires are bad," or any evidence to use in their statements, consider sharing a BIT of content here about some of the impacts of wildfires.

Don't be rigid in this sequence (such as always asking a question, then giving three students the chance to respond, then moving on). Take note of which ideas seem exciting or enlivening to students, and follow them.

You don't need to ask all the questions listed here. This is just a list of possible questions to use to engage students in thinking about how to manage wildfires. If your group really gets grooving on one question, let them keep discussing it. If you ask a question and it belly flops, then move on.

Reframe or call attention to significant changes in the group's thinking. Example: "Oh, interesting. So Alondra was saying that whether or not humans should stop fires from burning should depend on whether people's homes might be threatened, or whether or not it's safe to fight the fire. What do people think of that idea?" Or: "Wow, so earlier the whole group thought we should always stop fires from burning, but now we're more split; many of you are in favor of letting them burn. What made us change our thinking?"

g. Would a controlled burn be a good idea in our location? Why or why not?

h. How should we manage fires in fire-adapted ecosystems? What about in fire-adapted ecosystems where there is more fuel that will cause a very large fire if one were to start?

Wrapping Up the Discussion

1. **When the group has had a while to discuss the issue, but BEFORE they totally lose steam, wrap up the discussion by briefly summarizing the discussion.** Briefly describe how the group's ideas evolved, then share any conclusions that were reached, places of ongoing disagreement, or questions the group still has.

2. **Offer relevant information (briefly) about the local management strategies in place near your site.** Describe to students how the regional management system approaches managing fires where your site is, or where your students live.

3. **Point out how the kind of discussion students just participated in was similar to the type that environmental planners or scientists might have.**
   - *The kind of discussion you just had is one that environmental scientists, planners, and forest service staff often have.*
   - *Most decisions about how to manage human impacts on the environment, or prevent natural disasters, are this complex (or more!).*
   - *There are very rarely quick and easy solutions to anything.*

4. **Prompt students to keep thinking about the question, and to be open to changing their minds if they encounter new evidence or different ideas.** Tell students they can continue to consider the question. Encourage them to look for new evidence and ideas about the issue, and let them know it's OK—and in fact, great—to change their minds if they encounter new evidence, in this or any discussion.

5. **Use the following *Walk & Talk* questions as you leave the site.**
   - What is an example of when you changed your mind during the activity, and what made you change it? What did it feel like when that happened?
   - What made you learn during the activity?
   - What did you learn about being a productive participant in a discussion?

TEACHING NOTES

Connect it to the *Argumentation Routine*. If there are two or more claims that evolve throughout the discussion (for example, if half the group thinks humans should stop fires from burning, but others think they shouldn't, or if students disagree on which of these management strategies is most optimal), consider using one or more of the structures from the *Argumentation Routine* to help structure the discussion.

Confusion about the concept of "adaptation." In common English usage, the word "adapt" can refer to something an individual does, e.g., "I moved to a new school and I adapted by making new friends." But in biological scientific usage, individuals don't adapt, populations of organisms do, and they do this over generations when traits that help organisms survive become more common than other traits. "Fire-adapted ecosystems" is a term used to describe ecosystems that contain plants that are well adapted to fire. An ecosystem doesn't become "fire adapted" overnight, just as organisms don't rapidly "adapt" and gain new traits. If students share the idea of ecosystems "adapting" to fire as a reasonable solution to fire management, use the opportunity to contradict the misconception about the pace of adaptation as a whole.

Activities to help students understand "adapt." If your students are unclear on the meaning of the term "adapt," you might want to use some BEETLES adaptations-focused activities with them, such as *Structures & Behaviors,* or *Adaptations Intro Live!*

Instructor Support

Teaching Knowledge

TEACHING NOTES

Using Evidence Cards. Evidence Cards are a way for students to access information about the topic without the instructor directly telling it to them. This gives students more autonomy and increases their ability and confidence in seeking out and using information from written sources. When deciding how to use the Evidence Cards with a particular group, take into account your students' reading levels and ability to consider multiple pieces of evidence at once. For older students or those who have more advanced reading skills, you could hand out one or both sheets of evidence at the same time, and give groups of about 4 students time to read and discuss the new information before coming back to the whole group discussion. For students who are younger or need more time to read and process information, cut up the sheets of Evidence Cards and offer small groups just 1 or 2 cards to discuss at a time. You could offer all students the same 1 or 2 cards to discuss, or give each group a different piece of evidence to consider, then ask them to share their ideas with other groups. Another option, which might be particularly helpful if students don't have much background knowledge about fires, is to read the information from 1 or 2 cards to the whole group early in the discussion, ask them to use that information as evidence, and hand out the rest of the cards later on. For increased place-based relevancy, another option is to make your own Evidence Card about the fire management strategy in your area, and pass that out to students for discussion early in the activity. If it seems like it won't work for your group of students to discuss Evidence Cards in small groups, you can introduce evidence to the group by reading a card out loud, then asking students to discuss how it changes their thinking. If students don't really know what to do with the cards in their small groups, or if their discussion is lagging, consider telling them to organize the cards into "pro, con, and neutral" piles, with each pile representing evidence that could be used in support of or against the statement: "People should stop wildfires from burning."

Connect the discussion to your surroundings. Connect this discussion to your surroundings, and to students' observations. Ideally this activity takes place after students have had plenty of time getting to know the ecosystem, so it functions as an application of all they've learned so far. Ask the group to first consider how a wildfire might impact the organisms and ecosystems they've seen during your program. You can also prompt the group to think about their surroundings when introducing the idea of fuel, by asking them to think about what could serve as fuel around them, and what challenges might come up in managing a fire there.

Discussing environmental issues. Approaching management of resources and strategies for management is complicated! It's important to consider the needs and functions of different organisms in an ecosystem, and to think about the perspectives of different groups of people who might interact with or depend upon the ecosystem. Then there are the costs of different management strategies, their efficiency, and the reality of whether the proposed strategies are even possible. There are unknown consequences of different actions to attempt to predict and consider.

TEACHING NOTES

Regardless of the age of students, it's important for any discussions they have about environmental issues to reflect the complexity of making these kinds of decisions. Often, environmental issues (and decisions about how to manage the world in general) are thought of as simple, or simply two-sided. Logging is bad. Don't do it. Logging is good because it provides jobs. Fires are bad. Don't let them burn. In fact, every one of these issues is multifaceted. Deciding how to deal with any of them is challenging, requires considerations of multiple factors and parts in a system, and requires learning about cause and effect relationships in order to predict possible future outcomes. Considering these issues also requires humility, input from multiple people, and being comfortable with disagreement, in order to work towards a deeper understanding.

Stating this outright to students at the beginning and the end of the discussion is important framing. It helps set expectations for the discussion of a complicated issue and provides context about this type of conversation. Leading discussions is a complex skill, and participating in one is also complex! For more on building a culture of discussion and developing discussion-leading skills, see BEETLES *Encouraging Student Discussion* and *Productive Talk* resources and *Discussion Strategy Videos*.

Discussing a different topic. Should you want your students to discuss other environmental issues, pick a topic that is equally complex, and structure the discussion in a similar way. Ask students to share their initial thoughts, ask follow-up questions that probe their thinking, ask them to consider different aspects of the issue, offer new evidence, and keep moving the discussion along, including multiple voices and perspectives.

Conceptual Knowledge

Fire ecology is a complex subject. Some ecosystems are fire adapted. These ecosystems burn every 25 to 40 years. Mostly, these are made up of smaller brush and larger trees. Regular fires burn the brush to the ground, and the brush can regrow from its roots or from seeds. These smaller-scale fires typically do not completely burn or threaten larger trees, which are often adapted to survive these smaller brush fires by having thick, protective bark. After a small-scale fire, the ecosystem often recovers quickly, and is intact enough that animals can return to an area after a fire and still be able to survive. Some indigenous cultures even set fires intentionally in landscapes like this, to help renew the soil and manage the system.

In the last couple hundred years, most wildfires that have started in both fire adapted and non fire-adapted ecosystems have been put out by people. As a result, fuel like dead grasses, logs, branches, and other dead, dry vegetation has built up. Generally, this is more fuel than would be there normally. When fires start, the added fuel load leads to faster burning fires with higher flames hotter temperatures, which typically kill a higher number of trees than intermittent fires, and leave the ecosystem highly ravaged. It takes an ecosystem longer to recover from this large of a fire, if it ever does.

With this in mind, approaches to fire management have shifted in recent years. Currently, there are 3 main management approaches for wildfires. The first is to use bulldozers and other tools to clear out fuel in areas where it

has built up. The second is to start small-scale fires to clear out fuel in areas where it has built up. The third is to let fires burn once they have started, and to try to manage them and contain them to areas that need the fuel load to be reduced.

Each approach has pros and cons. The first approach is very expensive and somewhat impractical; it's difficult to completely remove fuel from such large areas. The second and third approaches, which both, in effect, are about letting fires burn, run the risk of the fire getting out of control and unintentionally burning other areas. Effects of wildfires on people can include loss of property and life, difficulty breathing (if residential areas are nearby), the cost and resources required to manage fires, and potential dangers to those who are fighting the fire. There is no clear answer about which approach is most effective.

Fire danger will continue to be a greater risk due to climate change. Rising average temperatures make the conditions for fighting fire more difficult once it has started. Drought leads to dry forest ecosystems that burn more quickly, and drought also stresses and has killed higher numbers of trees in many forests, particularly in the western United States. Fire management is an important and timely question for students to consider.

Connections to Next Generation Science Standards (NGSS)

BEETLES student activities are designed to provide opportunities for the "three-dimensional" learning that is called for in the NGSS. To experience three-dimensional learning, students need to engage in Science Practices to learn important science ideas (Disciplinary Core Ideas) and deepen their understanding by relating that content to overarching Crosscutting Concepts. Students should be exploring and investigating rich phenomena, and figuring out how the natural world works. The *Fire Management* mini-discussion engages students in the practice of Engaging in Argument from Evidence to build understanding of Disciplinary Core Ideas related to *Natural Hazards, Human Impacts on Ecosystems, Ecosystem Dynamics, Functioning, and Resilience*, and relate those ideas to the Crosscutting Concept of *Cause and Effect*.

Featured Science and Engineering Practices

Engaging students in Engaging in Argument from Evidence. The *Framework for K-12 Science Education* highlights the importance of reasoning and argument in determining the best explanation for a natural phenomenon. The *Framework* states that engaging in argument is critical to students' understanding of the culture of science. In *Fire Management Discussion*, as students support their ideas (claims) about how they think fires should be managed with evidence, critique each other's ideas, and reevaluate their own ideas based on new evidence, they gain practice with scientific argumentation. Be sure to continue probing students' claims about phenomena, asking them to critique each other's explanations based on the available evidence, and having them share why they agree or disagree, so they begin to internalize the practice of engaging in argument from evidence, and recognize it as a transferable skill.

TEACHING NOTES

About the Next Generation Science Standards (NGSS). The development of the Next Generation Science Standards followed closely on the movement to adopt nationwide English language arts and mathematics Common Core standards. In the case of the science standards, the National Research Council (NRC) first wrote a Framework for K-12 Science Education that beautifully describes an updated and comprehensive vision for proficiency in science across our nation. The Framework–validated by science researchers, educators and cognitive scientists–was then the basis for the development of the NGSS. As our understanding of how children learn has grown dramatically since the last science standards were published, the NGSS has pushed the science education community further towards engaging students in the practices used by scientists and engineers, and using the "big ideas" of science to actively learn about the natural world. Research shows that teaching science as a process of inquiry and explanation helps students to form a deeper understanding of science concepts and better recognize how science applies to everyday life. In order to emphasize these important aspects of science, the NGSS are organized into three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts and Disciplinary Core Ideas (DCI's). Read more about the Next Generation Science Standards at www.nextgenscience.org/ and ngss.nsta.org/.

Importance of teaching science practices. "Engaging in the practices of science helps students understand how scientific knowledge develops...It can also pique students' curiosity, capture their interest, and motivate their continued study..." -National Research Council, A Framework for K-12 Science Education. Focus on these science practices will help to ensure a more scientifically literate public who will be better able to make thoughtful decisions.

TEACHING NOTES

About Crosscutting Concepts in the NGSS. Crosscutting concepts are considered powerful thinking tools for how scientists make sense of the natural world. The seven "big ideas" listed as crosscutting concepts are: Patterns; Cause & Effect; Scale, Proportion & Quantity; Systems and System Models; Energy & Matter: Flows, Cycles and Conservation; Structure & Function; and Stability & Change. These concepts may sound familiar, as they are quite similar to the themes referred to in science literacy documents as being important ideas that unify all disciplines of science and engineering.

The Disciplinary Core Ideas (DCI's) are divided into four disciplines: Life Science (LS), Physical Science (PS), Earth and Space Science (ESS) and Engineering, Technology and Applied Science (ETS).

Featured Crosscutting Concepts

Learning science through the lens of *Cause and Effect.* When scientists make explanations of how or why something happens, they are thinking about the connection between cause and effect. Much of what we can observe of the natural world is the "effect" of many potential "causes." Applying the idea of cause and effect relationships leads to a deeper understanding of whatever specific natural phenomena students are studying, and also prepares students to make predictions and scientific explanations about what might happen in the future.

In *Fire Management Discussion*, students discuss the effects of fires on people and ecosystems and debate which fire management strategy causes the least harm. Though students are thinking about cause and effect throughout the activity, they may not realize the broader scientific application of the idea. Help students reflect on how the "lens" of cause and effect impacts their thinking, and how it could be useful when they're exploring other places, trying to explain aspects of other mysteries, or discussing other complex issues.

Featured Disciplinary Core Ideas

Building a foundation for understanding Disciplinary Core Ideas. The NGSS make it clear that students need multiple learning experiences to build their understanding of Disciplinary Core Ideas. *Fire Management Discussion* provides students with an opportunity to develop understanding of some Disciplinary Core Ideas relating to ESS3.C *Human Impacts on Ecosystems*, ESS3.B *Natural Hazards*, LS2.C *Ecosystem Dynamics, Functioning, and Resilience*.

When students consider how different fire management strategies alter the impact of fires on people and ecosystems, they develop an understanding about how human activities have major effects on the environment (ESS3.C), and how humans cannot eliminate natural hazards but can take steps to reduce their impacts (ESS3.B). As students read and discuss Evidence Cards about how different organisms respond differently to fires and how fire adapted ecosystems are naturally resilient to fires, they encounter ideas about how different organisms respond to environmental changes and how ecosystems respond to disturbances (LS2.C).

You can informally assess student understanding of these concepts during different stages of the activity through individual interactions with students, and by listening carefully during group discussions. This information can help you determine which ideas to focus on in future lessons so that follow-up activities or discussions can be used to further improve student understanding.

Performance Expectations to Work Toward

No single activity can adequately prepare someone for an NGSS performance expectation. Performance expectations are examples of things students should be able to do, after engaging in multiple learning experiences or long-term instructional units, to demonstrate their understanding of important core ideas and science practices, as well as their ability to apply the Crosscutting Concepts. They do not represent a "curriculum" to be taught to

students. Below are some of the performance expectations that this activity can help students work toward:

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Activity Connections and Additional Ideas

To continue to develop the practice of engaging in argument, use *Argumentation Routine, Walk & Talk, Turn & Talk, Most Successful Organism Discussion*, or *What Lives Here?*

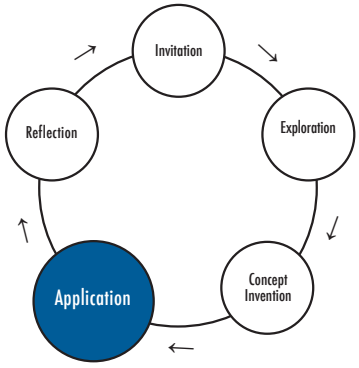
For more activities that integrate the Crosscutting Concept of cause and effect, use *Case of the Disappearing Log, Bark Beetle Exploration*, or *NSI: Nature Scene Investigators*.

To continue to develop student understanding of content related to Ecosystem Dynamics, Functioning, and Resilience use *Bark Beetle Exploration* or Ecosystem Theme Hike.

TEACHING NOTES

Translating the codes used in the NGSS. Each standard in the NGSS is organized as a collection of performance expectations (PE) for a particular science topic. Each PE has a specific code, provided here so that they can be easily referenced in the NGSS documents. The first number or initial refers to the grade level: K - kindergarten, 1 - first, 2 - second,etc...MS - middle school, and HS - high school. The next letters in the code refer to the science discipline for the standard: LS, PS, ESS, ETS. The number following the discipline denotes the specific core idea within the discipline that is addressed by the PE, and the last digit identifies the number of the PE itself.
So...3-LS4-4 means it's part of a third-grade standard (3) for life science (LS), addressing the fourth core idea (4), Biological Evolution: Unity and Diversity, within the life science standards, that deals with Biodiversity and Humans. It's also the fourth performance expectation (4) that makes up the complete LS4 standard at this grade level.

Learning Cycle stage for this entire activity as part of an extended learning experience.



Evidence Cards, page 1 of 2

See the Instructor Support section "Using Evidence Cards" on page 7 for more information.

Many animals- birds, insects, mammals can survive wildfires by running, flying, or tunneling to get away from the heat.

Some forests and ecosystems are **fire adapted.** The trees have thick bark that protects them from fire. Smaller plants like bushes or grasses burn quickly, but regrow from their roots. Many seeds of other plants can survive fire.

Fire adapted ecosystems usually burn every 5 to 25 years. These fires are not usually big enough to reach the tops of tall trees and burn them down. After these fires, many animals can return and still survive.

Aboriginal Australians and other native cultures set small fires on purpose at the beginning of every dry season. Some organizations like the Forest Service have started doing this too.

Some trees in **fire adapted ecosystems** have seeds that can only grow after a fire.

In some places, humans have prevented fires for many years, so lots of plants, sticks, logs, and other fuel build up on the forest floor. The high fuel load leads to hotter, higher, and faster burning fires, often killing lots of trees and changing forests so much that animals can't survive if they return after the fire.

During rains after a fire, landslides are more common because roots and plants no longer hold dirt in place. This can threaten homes and nearby ecosystems that survived the fire.

(CC) Washington State DOT via Flickr.com

Humans have stopped fires from spreading in most **fire adapted ecosystems** over the past 50 years. There's so much extra fuel in these forests that any fire there is likely to get out of control, burning and killing almost any living thing there.

(CC) David Prasad via Flickr.com

On average, the world is getting hotter. Longer summers, shorter winters, hotter temperatures, and drought all make it harder for people to stop wildfires from getting out of control, or to manage them safely.

(CC) Kevin Schultz via Flickr.com

Fighting the Soberanes Fire in California cost the country over 236 million US dollars.

(CC) CA National Guard via Flickr.com

During heavy fire seasons residents are forced to stay inside, because the air gets so smoky it's not safe to breathe. This is especially hard for people with asthma.

(CC) Kristal Kraft via Flickr.com

The Rim Fire, a huge wildfire in the summer of 2013, burned more than 400 square miles. This fire was so large because the area had not burned in a long time, and a lot of fuel built up on the forest floor. It's hard for a forest to recover from a fire of this size.

(CC) daveynin via Flickr.com

FIELD CARD

Cut out along outer lines and fold along the centerline. This makes a handy reference card that will fit in your pocket.

Fire Management Discussion

Introducing the Discussion

1. Introduce the topic of wildfires.
2. Review discussion norms, & challenge students to learn to be more productive participants in discussion.
3. Challenge students to be flexible thinkers, to change their minds about something during the activity, & to remember when this happens.
4. Have students access their prior knowledge about wildfires, through a Think, Pair, Share:

   ▶ *What do you know about wildfires?*

   ▶ *What do you know about how wildfires start, stop, and what causes them to get out of control?*
5. Hear a few student responses, ask follow-up questions, & introduce a bit of content about how fires start, spread, & stop. Sometimes fires are caused naturally by lightning strikes. *But most of the huge and destructive wildfires of recent times are started by people, by campfires getting out of control, by arson, or even by something as small as a spark from a train track hitting dry grass.*
   - *Fires need heat, oxygen, and fuel to burn and spread.* Fires spread faster when it's hot, dry, and windy; wet and cool weather slows them down. *Typically, the more dead/dry brush in an ecosystem, the higher the fuel load, and the higher the fire danger.* Fires spread faster when they're headed uphill, because the heat of the fire downhill heats up the fuel uphill.
   - *To stop wildfires, the main strategy is to take away all the fuel (water and fire retardants may also be used to reduce heat, but you can't remove oxygen or change the weather). Firefighters make a "fuel break" by using bulldozers and shovels to remove all of the fuel (including all trees, other plants, sticks, or anything flammable) around the edges of a fire, leaving a giant dirt line around the fire.* Once the fire burns through all the fuel inside the break, it stops (hopefully).
6. Introduce the main question to students, and give them a moment to *Turn & Talk* about their initial thoughts.

   ▶ *Think about this question, then I'll signal when it's time to discuss your ideas with a partner: "Should humans stop wildfires from burning?" (or "If a fire started here, in this area, should humans stop it?"*
7. Hear some student responses, & ask them to share their reasoning.
8. Summarize the group's initial positions, & tell students they'll think together about the issue from different perspectives, considering different evidence.

Engaging in Deeper Discussion

1. Introduce "ecosystem" as a community in nature of living and nonliving things that are connected with each other.
2. Name the type of ecosystem you are in and ask students to brainstorm different ecosystems.
3. Ask students to think and discuss how a wildfire might impact the ecosystem around them:

   ▶ *Think about what you've seen of this ecosystem. How might a wildfire impact this ecosystem and what is your evidence?"*
4. Ask students to look at the surrounding ecosystem and discuss what might be "fuel" for a fire, and whether they think there's more or less of a fuel load than in other ecosystems.
5. Ask students to then discuss how fire might impact other ecosystems, hear a few answers, then move on:

   ▶ *How might different amounts of fuel in different ecosystems impact how a wildfire behaves in and impacts an ecosystem? Share your evidence and reasoning.*
6. In no specific sequence, ask students to discuss some (but not all) questions below, first in the whole group, then in a small group (with Evidence Cards), and finally in whole group again:
   - *What are ways wildfires could impact people?*

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FIELD CARD

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- *Are all people impacted equally by the effects of forest fires? Why or why not?*
- *Who do you think should be responsible for deciding how to manage wildfires?*
- *There are 3 main strategies for managing fires: moving fuel, starting smaller fires to burn through fuel, and letting fires burn once they have started. Discuss each option, thinking about positives and drawbacks for each.*
- *Original question again: Should people stop wildfires once they begin? Why or why not.*
- [If students say how people should react to fires should depend on the situation.] *In which situations should humans stop fires? In which situations shouldn't they? What are benefits or drawbacks to each of these approaches?*
- *Would a controlled burn be a good idea in our location? Why or why not?*
- *How should we manage fires in fire-adapted ecosystems? What about in fire-adapted ecosystems where there is more fuel that will cause a very large fire if one were to start?*

Wrapping Up the Discussion

1. When the group has had a while to discuss the issue, but BEFORE they totally lose steam, wrap up the discussion by briefly summarizing the discussion.
2. Offer relevant information (briefly) about the local management strategies in place near your site.
3. Point out how the kind of discussion students just participated in was similar to the type that environmental planners or scientists might have.

   ▶ *The kind of discussion you just had is one environmental scientists, planners, and forest service staff often have.*

   ▶ *Most decisions about how to manage human impacts on the environment, or prevent natural disasters, are this complex (or more!).*

   ▶ *There are very rarely quick and easy solutions to anything.*
4. Prompt students to keep thinking about the question, and to be open to changing their minds if they encounter new evidence or different ideas.
5. Use the following Walk & Talk questions as you leave the site.

   ▶ *What is an example of when you changed your mind during the activity, and what made you change it? What did it feel like when that happened?*

   ▶ *What made you learn during the activity?*

   ▶ *What did you learn about being a productive participant in a discussion?*

ABOUT BEETLES™

BEETLES™ (Better Environmental Education Teaching, Learning, and Expertise Sharing) is a program of The Lawrence Hall of Science at the University of California, Berkeley, that provides professional learning sessions, student activities, and supporting resources for outdoor science program leaders and their staff. The goal is to infuse outdoor science programs everywhere with research-based approaches and tools to science teaching and learning that help them continually improve their programs.

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