GENERATION BEYOND

TOPIC

Surveillance: Wild Fire Response

KEY LEARNING OBJECTIVES

Students will be able to:

- Understand the human and economic costs of wildfires

- Evaluate current technology used to respond to wildfires

- Demonstrate how autonomous and piloted aerial devices can make positive contributions to wildfire response protocols

LESSON OVERVIEW

In this lesson, teams will investigate the causes of wildfires and their associated human and economic costs. Students will investigate the different types of wildfires and appropriate responses and strategies for fighting different fires. Students will also investigate how modern technology can help firefighting professionals determine the best response to a fire in terms of minimizing risk while also maximizing containment. Student teams will use this information to suggest how to integrate a high-tech device into the fire response protocol and the data that the device should provide.

The accompanying presentation was created with PowerPoint so that it can be used in a variety of classrooms. If you are using a laptop with an LCD projector, simply progress through the PowerPoint by clicking to advance. All of the interactive aspects of the presentation are set to occur on click. Links to the corresponding videos can be found in the notes section of the PowerPoint. If you are using an interactive whiteboard, tap on each slide with your finger or stylus to activate the interactive aspects of the presentation. It does not matter where you tap, but you can make it appear as if you are making certain things happen by tapping them. In the notes for each slide, there will be information on how to proceed.

CONTENT AREAS

Earth Science

ACTIVITY DURATION

3 class sessions (45 minutes each)

GRADE LEVEL

Grades 9–12

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ESSENTIAL QUESTIONS

1. What is a wildfire?

2. What causes wildfires?

3. What effect does a wildfire have on people and economies?

4. How is technology currently used to develop the best response to a wildfire?

MATERIALS

- Colored marking pens

- "Racing Fire" Student Activity Sheet

- "Fighting Wildfires" Student Activity Sheet

- Challenge Document

- Student Capture Sheets

- Student Reference Sheet: Controlling Wildfires

BACKGROUND INFO

Between 1980 and 2016, millions of acres of forests and grasslands were lost to wildfire. Billions of dollars in damage resulted from the health hazards caused by wildfire smoke in the atmosphere. Some areas devastated by wildfire have never returned to their original ecosystem.

Since wildfires usually begin far from most human habitation, they are typically noticed only when they have become large. Moving rapidly, wildfires give fire responders very little time to decide how to respond. The professionals tasked with controlling a raging fire must make quick decisions about the types and quantities of resources to deploy. Resources that are sent to a wildfire are always at risk, and that risk must be evaluated in terms of the potential damage the wildfire represents. As advances in technology become more available, firefighters are asking how technology can be used to help control wildfires while also minimizing risk.

This guide was created to give educators ideas and strategies for presenting the content in the digital lesson. It provides slide-by-slide details for educators to engage with students as they explain, discuss, and effectively facilitate the content in the presentation. The presentation is designed to cover three 45-minute class sessions, but it is flexible, depending on individual needs and time available.

NATIONAL STANDARDS
Next Generation Science Standards
High school

ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Defining and Delimiting Engineering Problems
Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)

ETS1.B: Developing Possible Solutions
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)

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PROCEDURE
DAY 1
Engage (Slides 1–3)

Overview: Students will be asked whether they have ever experienced a campfire, bonfire, or leaf burn that suddenly looked like it was burning faster than expected. They will be asked to think about how much force a wildfire has and how fast they think a wildfire travels. Students will learn that a wildfire requires the same components as any other fire. Fire is a chemical reaction of combustion. Students will then be introduced to some facts about wildfires and compare their speed to that of a wildfire.

Slide 1

- Introduce students to this life-saving challenge by connecting what they are learning to their own lives to unpack the mission!

    - Tell students to make a dot in the middle of their paper and write the topic, "Wildfires" just above the dot.

    - Next, have students put a dot at the top of the page and write their name next to it. Explain to students that today they will be making connections from their topic to their lives.

    - Play the Wildfire Response video segment and pause every minute. Each time you pause, students should add a dot between the topic and their name. Next to the dot, they should add information and concepts from the segment that connect to the topic, but also have meaning for them personally.

    - Repeat this process throughout the video segment. When they finish, students should have a series of supporting details connecting the topic dot-to-dot with their name.

    - Have students share their dot diagram with a partner.

    - Complete this activity with a whole group discussion, asking students to share their personal connections to the STEM mission to the class.

Slides 2–3

- Ask students if they have ever been around a campfire or leaf fire where a sudden gust of wind blew an ember out of the fire and onto a space of ground a distance away. What happened with that ember? How was it contained before spreading further?

- Have students share what they know about wildfires. What are they? What preconceptions do the students have about how quickly wildfires can travel? (Students may have ideas about how big wildfires can get or how hot they can burn. From the experiences they have had with fires, they may know that fires give off dangerous gases. From watching the news, they might know that wildfires can spread quickly.)

- Display Slide 2 to the class. Point out that fire is a chemical reaction called combustion that relies on three variables. Use the click-to-reveal method to share the variables involved in forest and grassland fires.

- Display Slide 3 to the class. Discuss the specifics of wildfires, and emphasize that a wildfire is an **uncontrolled** event when it begins. Emphasize the speed at which wildfires can travel.

- Distribute the "Racing Fire" Student Activity Sheet. Have students complete the activity. Lead a discussion about how quickly the students walked or ran compared to the speed of a fast fire.

Explore (Slides 4–5)

Overview: Students will learn about the causes of wildfires. They will learn that wildfires are increasing in frequency and can damage millions of acres of land year every year and cost society billions of dollars a year in damages and containment efforts.

Slide 4

- Ask students to think about the causes of wildfires. What likely happens to start the spark that ends up as a wall of flame moving quickly through a forest or grassland?

- Display Slide 4. Compare students' ideas about the causes of wildfires to the facts. Encourage students to comment on the fact that the vast majority of wildfires are caused by people. Did they expect the percentage to be that high?

- Review the carelessness that might lead to a wildfire but point out that the intentional desire to start a fire by arson is also a cause of wildfires.

Slide 5

- Show Slide 5. Now that students have an idea of what a wildfire is and what it can do, ask students to brainstorm about *why* the number of wildfires is increasing.

- Explain that extended droughts in many Western states are contributing to more frequent fires that move quickly and burn very large areas. Dried grass, trees, leaves, and shrubs are volatile fuel for fire.

DAY 2
Explain (Slide 6–8)

Overview: Students will be introduced to the idea that controlling a wildfire means controlling one or more of the variables involved in the chemical reaction that results in fire. Responders to wildfires rely on timely information about these variables to safely do their jobs. Students will be asked to think about the type of technology needed to observe and detect wildfires, communicate and analyze information about them, and communicate alerts, if necessary.

Slide 7

- Show Slide 7. Have students discuss whether a wildfire can be stopped or just contained.

- Ask students to think of ways they might put out a wildfire. Specifically:

    - How can fuel be removed from a wildfire?

    - How can heat be removed from a wildfire?

    - How can oxygen be removed from a wildfire?

- Have students brainstorm the information they would need to know about the wildfire to decide how best to fight it.

- Distribute Student Reference Document #1: Controlling Wildfires. Have students read the information, then discuss in their own words how each technology or strategy can stop a fire; answers should focus on the three main variables necessary for combustion (fuel, heat, oxygen). Emphasize that both autonomous and piloted devices are used to fight wildfires.

Slide 8

- Show Slide 8. Discuss each point with students. Why is having this information important to making a decision about how best to respond to a particular fire?

- Ask: How might a surface fire require different responses from a crown fire?

- Ask: How might the response be different if a fire is moving relatively slowly or quickly?

- Ask: Why is it important for responders to know the direction in which a fire is traveling?

- Distribute "Fighting Wildfires" Student Activity Sheet.

ELABORATE (SLIDES 11–12)

Overview: Students are introduced to the idea of technologies that might be integrated to help firefighters control wildfires. Autonomous and piloted aerial devices are examples of technologies used to give fire responders real-time data on fires. With autonomous devices, a fire can be analyzed without putting a firefighter at risk. Devices can also be integrated into an overall response system. Piloted devices can bring fire and medical personnel into a specific area to help control the fire, evacuate trapped people, and administer medical aid.

Slide 11

- Show slide 8. Ask: How can technology help support wildfire response? Have students brainstorm about sensors or devices that could provide information to responders. What information could be obtained? What are some devices that might be used?

- Use a click-to-reveal to identify four examples of how technology could provide specific information that would be useful to firefighters dealing with a wildfire.

- Ask students to think about *how* detection devices, cameras, or flame-fighting materials can safely get to the fire areas.

- Ask students to think about how piloted devices are currently used in search and rescue, emergency medical transport, and humanitarian missions after natural disasters. What would a piloted device going into a fire need to carry? What features would a piloted device need to have to be effective?

Slide 12

- Show slide 9. Review the scene presented. This is a lead-in to the Challenge, in which students will need to think about these factors when developing a response to a wildfire scenario.

EVALUATE (SLIDE 10)

Overview: Students are presented with the Challenge of using autonomous vehicles, either independently or as part of a system, to respond to a wildfire event.

Slide 10

- Show the Challenge slide, then distribute the Student Challenge documents, including the Student Capture Sheets. Review the request, task, and map. Answer any questions students may have regarding the Challenge.

LOCKHEED MARTIN

In this activity, you will measure how quickly you walk and run and compare these data to wildfire speeds.

MATERIALS

Measuring tape or meter stick

Stopwatch

Chart to collect data

PROCEDURE

1. Use the measuring tape or meter stick to record the length of a hall or a similar distance on the sidewalk.
2. Have one member of your team use the stopwatch to time how long it takes another student to walk at a normal pace down the distance you measured.
3. Then, have the same team member run the same distance as the timekeeper notates the time.

What were the student's walking and running speeds, in meters per second?
(Remember, speed equals distance divided by time.)

What are these speeds in miles per hour? (Each m/s is approximately equal to 2.2 mph.)

A wildfire can move at more than 6 mph through a forest. In grassland, it can move at nearly 14 mph.
Would you be able to outrun a wildfire?

Source: https://www.fs.fed.us/managing-land/fire

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In this activity, you'll conduct a quick Internet search to learn about the following methods of fighting wildfires.

MATERIALS

Paper and pen to take notes on the different types of wildfire response activities

PROCEDURE

Using the following keywords, search the Internet to learn about actions that firefighters can take to respond to a wildfire. Also, note the types of fires for which the different responses are employed.

- **fire lines or firebreaks**
- **firing out**
- **aircraft**

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STUDENT REFERENCE SHEET | CONTROLLING WILDFIRES

Firefighters use different technologies and strategies to control wildfires, including autonomous observation and data collecting devices, firelines, unmanned aerial vehicles, and piloted air vehicles. As you review these technologies, think about how each can be integrated into the strategies that firefighters use to control wildfires.

Autonomous Observation and Data Collecting Devices

Main Purpose: These aircraft deliver personnel and equipment to a specific fire site; they also provide evacuation and medical support, as needed. For example, this Sikorsky S-70 FIREHAWK® is a multi-mission helicopter equipped with a 3,785-liter (1,000-gallon) water tank, retractable snorkel attached to the belly of the aircraft and an extended main landing gear. Helicopters like this one also include a rescue hoist and a medically-configured interior to support the extraction and medical needs of people trapped within a fire zone.

The Sikorsky FIREHAWK helicopter enables firefighters to attack wildland fires with large volumes of water, especially when the effort is coordinated closely with firefighters attacking the same fire from the ground.

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FIRELINES

Main Purpose: This strategy removes fuel to prevent the fire from spreading. Firelines are intended to contain a fire by clearing away any combustible material. Bulldozers, tractors, and personnel with shovels dig large, wide trenches. Any material that could ignite is removed and put at a distance from the trench. The trench has to be wide enough that the fire cannot 'jump' over it. This is a danger when the wind velocity suddenly increases; burning embers blown over and across the trench could ignite fuel materials (such as forest debris) across the trench, helping the fire to spread. Firelines are especially useful in containing slow-moving fires that have not spread over a very large area.

UNMANNED AERIAL VEHICLE (UAV)

Main Purpose: UAVs, which are larger than autonomous observation and data collecting devices, allow for the autonomous delivery of a payload, such as water, chemical fire retardant, or first aid supplies to a fire location. By removing oxygen and heat from the combustion equation, UAVs can keep a wildfire from spreading; they are often used in conjunction with other firefighting approaches, such as firelines. A UAV can also deliver fire tents and first aid equipment for victims caught in the fire, provide urgent help until a larger, manned vehicle can arrive.

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