



## Lesson 3: Fire Physics & Ignitions

### Examining Wildfire Causes and Preventions

**Guiding Question:** What causes wildfires?

**Goals:**

- To introduce students to the Fire Triangle and the Fire Behavior Triangle.
- To build awareness of natural and human-caused wildfire ignition sources.
- To empower students to take an active role in community education by sharing their knowledge of how to reduce human-caused ignitions.

**Objectives**

Students will be able to:

- 1) Explain how topography, weather, and fuel affect wildfire behavior.
- 2) Identify three human-caused and one natural cause of wildfire.
- 3) Explain actions that can be taken to reduce human-caused wildfire ignitions.

**Materials and Preparation:**

- Prepare materials for students to create a wildfire public service announcement (PSA). Depending on the format chosen, this could be materials to make a poster, flyer, or sticker. It could also be the equipment to record, edit, and share a short video or audio message.
- Prepare PowerPoint slideshow for *Lesson 3: Fire Physics & Ignitions*.
- Students will need their wildfire journals in class.

**Subjects:** Science, Listening and Speaking, Writing, Art (optional)

**Duration:** 60 minutes  
(Not including time to make final PSA.)

**Setting:** Classroom

**Vocabulary:**  
 The Fire Triangle:  
 (Fuel, Heat, Oxygen)  
 The Fire Behavior Triangle:  
 (Topography, Weather, Fuel)  
 Humidity, Slope, Wildland Urban Interface, Ignition

<b>Standards:</b>		
<b>NGSS</b>	Crosscutting Concepts	Stability and Change Cause and Effect Energy and Matter
	Science and Engineering Practices	Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Obtaining, Evaluating, and Communicating Information
	Disciplinary Core Ideas	PSI.B Chemical Reactions ESS2.D Weather and Climate ESS3.B Natural Hazards

		ESS3.C Human Impact on Earth Systems ESS3.D Global Climate Change
<b>Environmental Principles and Concepts</b>		Principle 2: People Influence Natural Systems Principle 3: Natural Systems Change in Ways that People Benefit From and Can Influence Principle 5: Decisions Affecting Resources and Natural Systems are Complex and Involve Many Factors

**Lesson Overview:**

Students are introduced to fire physics and behavior by talking about the points of the Fire Triangle and the Fire Behavior Triangle. The Fire Triangle is a simple way of understanding the elements of fire. The sides of the triangle represent the interdependent ingredients needed for fire: heat, fuel, and oxygen. The Fire Behavior Triangle includes the three factors of topography, fuel, and weather. This lesson gives a brief introduction to these two topics, with FireWorks lessons recommended for extended learning and opportunities to use fire in demonstrations and experiments.

This lesson introduces environmental and human factors in Butte County that contributes to the area’s high wildfire severity. One factor is the wildland urban interface (WUI), where housing meets or intermingles with wildland areas, putting many communities at high risk. Students learn about sources of wildfire ignitions, which are largely human-caused. Human-caused fires could be the result of intent (arson), errors (unattended campfire), or accidents in human-built infrastructures or technologies (powerline failure). After learning about the most common ignition sources in Butte County over ten years, students assess sample PSAs from campaigns working to reduce accidental wildfire ignitions.

For the assessment activity, students pick a wildfire ignition source and do an independent study to learn more about it. Students then create an educational PSA, independently or in a small group. Students present their creations to the class and explain the message they think everyone in their community should be aware of. Your class is encouraged to share their work with the Butte County Fire Safe Council by emailing links or attachments to [Laurendeterra@buttefiresafe.net](mailto:Laurendeterra@buttefiresafe.net). Selected PSAs can be featured on our social media and website or used in future community education campaigns.

**Procedure:**

1. Explain to students: We have learned how fire is an essential part of healthy ecosystems and how humans play an important role in maintaining fire in the landscape. Fires that are intentionally started for land management and cultural reasons need to be done correctly, with a strong knowledge of that ecosystem, environmental conditions, and fire safety. If done properly, these fires typically do not turn into dangerous wildfires. We will learn more about intentional, prescribed fire in a later lesson, but today we will

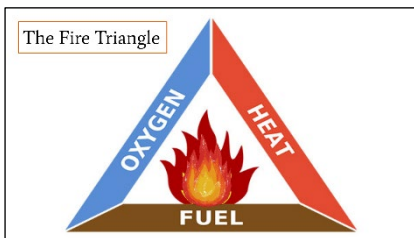
focus on the fires that are started accidentally and what can be done about this problem.

2. Go through presentation slides for *Lesson 3: Fire Physics & Ignitions*.



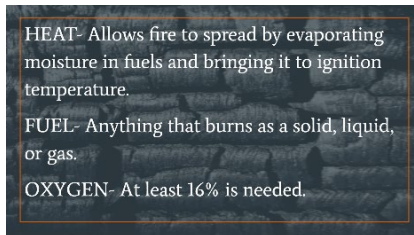
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Discussion: Students share previous knowledge they have about what a fire needs to burn. Guide them to think about three essential things that a fire could not start or continue without.



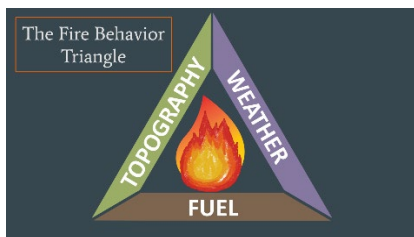
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The Fire Triangle is a simple way of understanding the elements of fire. The sides of the triangle represent the interdependent ingredients needed for fire: heat, fuel, and oxygen. For a simple example, invite students to think of a burning candle. Where does the burning candle get the heat to light from? What is the fuel burned? How might oxygen be added or taken away from the candle?



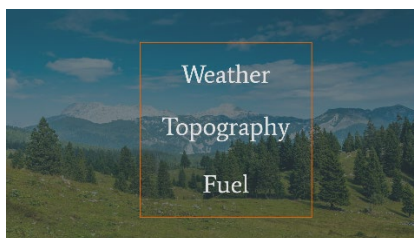
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A **heat** source is responsible for the initial ignition of fire and is needed to maintain and spread it. Heat allows fire to spread by drying and preheating nearby fuel and warming surrounding air. **Fuel** is characterized by its moisture content, size, shape, quantity, and the arrangement on the landscape. **Oxygen** supports the chemical processes that occur during fire. When fuel burns, it reacts with oxygen from the surrounding air, releasing heat and generating combustion products (gases, water, smoke, embers).



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Three factors that determine fire behavior are topography, weather, and fuel. Depending on these factors, a fire can quickly burn out or turn into a large wildfire. There are three **weather** ingredients that can affect wildfires: temperature, wind, and moisture. Wind supplies the fire with additional oxygen, dries out fuel, and pushes fire across the land at a faster rate. Wind is the most critical factor affecting wildfire behavior. Moisture, in the form of humidity and precipitation, can slow the fire down and reduce its intensity. The higher the relative humidity, the lower the temperature, and the less likely fuel is to dry out and ignite. **Topography** includes physical land features such as mountains, plateaus, canyons, plains, and valleys. The steeper the slope, the faster fire travels. Fire preheats uphill fuel from rising smoke and heat. **Fuel** is the common denominator of both fire triangles. Depending on the plant species present, vegetation fuels will influence fire behavior differently.



How could each factor affect a wildfire?

- Winds of 40 mph in September.
- A day with 30% relative humidity.
- Cool overnight temperatures of 50 ° F.
- A flat meadow with green grass and blue oak trees.
- A 30 degree slope with dead ponderosa pine trees.

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Review the two fire triangles by thinking about the following:  
Which factors could lead to the highest severity fire?  
Which factors could support firefighters if they were trying to stop a wildfire?

What factors increase Butte County's wildfire severity?

- Mediterranean climate with seasonal drought
- Low humidity with high temperatures in summer and fall
- Topography with 60 to 7,000 foot elevation range
- Plants that dry out in the summer, some non-native
- Seasonal dry north winds
- Wildland Urban Interface (WUI) areas

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What is a Wildland Urban Interface?

The area where houses meet or intermingle with undeveloped wildland vegetation.



WUI pronounced: "Woo-E". Notice in this photograph how a fire burned right up to the edge of a housing development that meets the wildlands.

WUI statistics from the U.S. Fire Administration (As of 2021)

- 46 million residences in 70,000 communities in the United States are at risk for WUI fires.
- California is the state with the greatest number of houses in the WUI: an estimated 30-45%.
- The WUI area continues to grow by approximately 2 million acres per year.

Notice in this photograph how the houses are mixed in with the forest.



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This is an example of WUI "intermingling". The importance of defensible space will be the focus of Lesson 5: Fire Resistant Structures.

What are some sources that could ignite a wildfire?

List in your journal as many as you can think of.

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In past lessons, you have learned how people, past and present, use fire as a tool to manage more fire-safe and healthy landscapes. This does not include accidental wildfire ignitions, which extends the fire season and can cause great harm. An ignition is the point at which a fire starts.

Student quick write: What are some sources that could ignite a wildfire?

Starting a journal list will set-up students to pick a wildfire PSA topic at the end of the lesson.

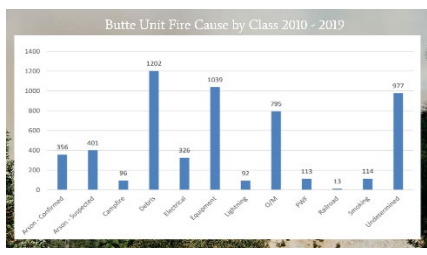
Perhaps you thought of some of these...

- Unattended campfires
- Burning debris piles
- Equipment malfunction
- Discarded cigarettes
- Arson
- Fireworks
- Playing with matches
- Downed power lines
- Lightning
- Heat from vehicles
- Escaped prescribed fire
- Volcanic activity
- Car crashes



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How do you think most wildfires start in Butte County? (Not the sources of the largest fires, but the sources that occur most often.)



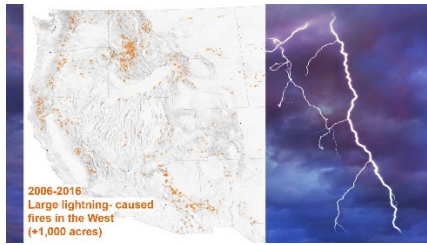
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From Butte County Community Wildfire Protection Plan p.82  
<https://buttecounty.sacriver.org/cwpp/butte-county-cwpp-report>  
 1) Debris burning 2) Equipment 3)Undetermined  
 O/M= Operations and Maintenance

Nearly 85% of wildland fires in the United States are caused by humans.

What's The Leading Cause Of Wildfires In the U.S.? Humans  
 NPR All Things Considered (Feb, 2017)  
 3-minute listen

[Listen Here](#) 



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Lightning strikes are the primary natural cause of wildfire. Notice where the large lightning-caused fires are clustered on the map, in rural areas with higher elevations. These fires take longer to respond to because of their remoteness and they start in high fuel areas.

“Climate change is a major factor in the growing impact of lightning strikes, because these areas of the West are becoming more dried out. A lightning fire that might not have spread so quickly decades ago leaps across the landscape of dry vegetation.”  
 -New York Times (Map taken from article linked in slide notes.)

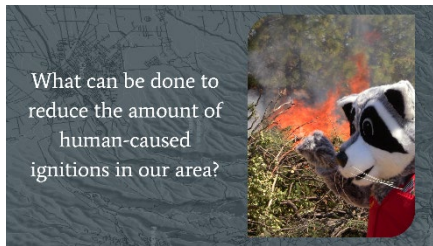


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“Hot and dry. These are the watchwords for large fires. While every fire needs a spark to ignite and fuel to burn, the hot and dry conditions in the atmosphere determine the likelihood of a fire starting, its intensity and the speed at which it spreads. Over the past several decades, as the world has increasingly warmed, so has its potential to burn.”  
 -Ellen Gray, NASA's Earth Science News Team

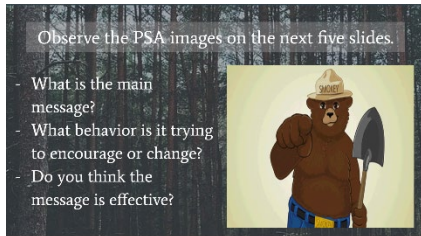
Additionally, decades of fire suppression in California has led to fuel build-up which increases fires' size and intensity.





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We can't stop lightning, but there are precautions people can take to reduce the likelihood they start an accidental wildfire.



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Another way to reach people is through video or audio messages. Example: One Less Spark Campaign public service announcements. On their website you can hear 14 examples of 30-second audio PSAs in English and Spanish.  
[One Less Spark Campaign Toolkit](#)

(Five examples of wildfire PSAs, slides 21-25.)



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Resources for learning more about ignitions:  
 (Burning Debris, Equipment Issues and Unruly Engine Sparks, Lit Cigarettes, Unsupervised Activities, Unattended Campfires)  
<https://science.howstuffworks.com/nature/natural-disasters/5-ways-wildfires-start.htm>  
 One Less Spark PSAs  
<https://www.readyforwildfire.org/prevent-wildfire/one-less-spark-campaign/one-less-spark-campaign-toolkit/>  
 Smokey Bear- Prevention How-To's  
<https://www.smokeybear.com/en/prevention-how-tos>



**Assessment:** Students research an ignition source, create a wildfire PSA, and share their work to reduce accidental ignitions in their area.

1. Students pick a wildfire ignition source. It may be one they listed earlier in their journal, or a topic shown in one of the PSA examples.
2. Students do independent research through reading articles or reviewing one of the suggested websites to find out more information about the ignition source they picked. Research does not have to be about a specific wildfire started in Butte County. It may be

better to avoid researching recent fires in your area, which could be traumatic for students to re-visit.

3. Students brainstorm in their journals by responding to the following questions (Slide 29)
  - What is the action or situation that could lead to an accidental wildfire?
  - What can be done to prevent this from happening and/or what behavior should be changed?
  - Why is it important that people are aware of this topic?
  - What format would I use for my PSA and why is this an effective method for reaching people?  
(Poster, flyer, sticker, logo, video, audio, or social media campaign.)
4. Students make a sketch or outline of what their PSA will include. Students then create their products, either in class or at home.
5. Students share their final product with a one-minute presentation to the class or a small group.

**Evaluation:**

<b>Wildfire PSA Activity</b>	<b>Good</b>	<b>Fair</b>	<b>Poor</b>
Brainstorm and Outline	Students fully answered all four questions and made a complete sketch or outline in their journal.	Students partially answered the questions or had an incomplete sketch or outline.	Students answered two or less of the questions and did not include a sketch or outline.
Final Product	Students created a wildfire PSA product that provides meaningful information and visuals about an ignition source.	Students created a wildfire PSA product, but it may be missing useful information, or it is visually incomplete.	Students created a product that does not relate to wildfire ignitions or provides inaccurate information.
Sharing	Students can confidently explain the ignition source behind their PSA and their main message.	Students can adequately explain the ignition source behind their PSA and their main message.	Students cannot explain the ignition source behind their PSA or their main message.

**Lesson Extension Recommendations:**

FireWorks: Northern California Oak Woodlands

The Fire Physics lesson cycle has six lessons that use fire in experiments and demonstrations.

<https://www.frames.gov/fireworks/curriculum/norcal-oak-woodlands>

FireWorks: Fire in the Sierra Nevada

M08: Fire Behavior, Fire Weather, and Climate

<https://www.frames.gov/catalog/24549>

REDI Jedi Master Program

Lesson 4: Terrain, Heat Transfer & Rate of Spread

Lesson 5: Weather & Fire Behavior

Lesson 6: Plans Moisture & Fire Combustion

*Coming Soon! Available Early 2022.*