

Template for Developing GRC Lessons  
Aligned to Three-Dimensional Science Standard

**3D-Student Science Performance**

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**Grade: High School Biology**

**Lesson Topic: Ecological Succession**

**Lesson Title:**

**Get Fired Up!**

**Performance Expectations (Standard) from State Standards or NGSS:**

**HS-LS2-6.** Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. *[Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood, and extreme changes, such as volcanic eruption or sea level rise.]*

**Performance Expectations (Standard) from the AZ State Standards**

**HS.L2U3.18** Obtain, evaluate, and communicate information about the positive and negative ethical, social, economic, and political implications of human activity on the biodiversity of an ecosystem.

**HS+B.L4U1.2** Engage in argument from the evidence that changes in environmental conditions or human interventions may change species diversity in an ecosystem.

**Lesson Performance Expectations: -**

- Plan and carry out an investigation to determine the effects of high temperatures on the living organisms in forest soil.
- Develop an argument for how the evidence gathered in an investigation supports the explanation that forest fires can be beneficial as well as destructive.

**Student Science Performance**

**Phenomenon: The forest in northern Arizona near Flagstaff Camp wildfire burn looks different since the fire.**

*(Teaching Suggestions: Place suggestions for how to present and engage students in the phenomenon.)*

**Gather**

1. Students obtain information by watching videos to observe changes to areas before and after forest fires.
2. Students develop questions to investigate changes to the ecosystems caused by forest fires.

*(Teaching Suggestions: Examples of videos to use in the introduction of the phenomenon.*

1. [Video: Kuark forest before and after the fires](#))

**Class Discussion about Good Questions to Investigate**

3. Students obtain information about the effects of high temperatures from fires on soil ecosystems.
4. Students plan and carry out an investigation to determine the effects of high temperatures on the living organisms in forest soil.  
*(Materials - Soil, metal pie tin, microscope, oven, petri dish with nutrient agar.)*

**Class Discussion about procedures and safety for the investigation**

5. Students obtain information about changes in the forest ecosystem after fires.

*Powerful Instructional Practices*

*Engage Students in Making Sense of Phenomena*

*Developing questions to plan and carry out investigations, design solutions, and obtain information*

*Gathering data and information to use in developing evidence*

*Reasoning about how the evidence supports an explanation for the cause of phenomenon*

*Engaging in Academic*

*Discourse*

((Teaching Suggestions: #3 students obtain information from - Video: [PHC Film: Soil is a living organism](#), Article: [Fire Effects on Soils - USDA Forest Service](#)  
#4 Materials for the Investigation - Oven, Soil, dissecting microscope for viewing scopes, nutrient agar dishes 6 per group. You will want students to test multiple samples of soil so they can see patterns in the observations. You will need to collect samples of soil from forested areas and bring it to class for students to use. It is recommended to bake some samples of soil to simulate a fire.)

Teaching Suggestions: #5 [Video: How Fire Can Restore a Forest: A Time-Lapse \(Tree View\)](#), [Article: The Ecological Benefits of Fire](#),

*Presenting Evidence of Learning***Reason**

6. Students **develop a model** to show **changes** to a forest ecosystem **caused** by fire.
7. Students **construct an explanation** for how wildfires **cause changes** to forest ecosystems.

*Communicating Reasoning Through Individual 3D Performance***Class Discussion:**

Questions to initiate Discussion:

Q: What patterns did you see in your data from the investigation?

Q: How were the microbes affected by burning the soil in the oven?

Q: How were the larger organisms in the soil affected by burning the soil in the oven?

Q: How does changing an ecosystem change the types of organisms growing in that ecosystem?

Q: How does the succession process return the environment to a more stable ecosystem?

Q: Why can the effect of fire be both beneficial as well as destructive for the forests?

Q: How does the model predict what land managers should do before, during, and after a fire?

Q: Where have you observed an ecosystem revitalizing after a big change (i.e., a flood)?

(Teaching Suggestions: Focus students on the fragility and interconnectedness of the forest ecosystem; if one thing changes, many other things will change.)

8. Students **construct an explanation** for how forest fires can be beneficial as well as destructive.

**Communicate Reasoning**

9. Students **develop an argument** for how the evidence they gathered supports the **explanation** that forest fires can be beneficial as well as destructive.

(Teaching Suggestions: if needed)

**Beyond the Classroom**

Invite students to investigate phenomena beyond the classroom and apply them to make sense of analogous phenomena. Establish electronic photo albums, student logs, and/or bulletin boards for students to share their observations. Encourage students to maintain notebooks, lists, and journals to document phenomena encountered beyond the classroom.

Think of other disturbances besides wildfires that can wipe out a natural environment and lead to secondary succession (hurricanes, floods, volcanic eruptions, abandoned cities, abandoned farms). Describe or show (comic strip) an ecosystem before, during or after a disturbance.



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### Formative Assessment for Student Learning

**Elicit Evidence of Learning:** Develop an argument for how the evidence you gathered supports the explanation that forest fires can be beneficial as well as destructive.

<p><b>Evidence of Student Proficiency</b> <i>Students will provide an explanation and give specific examples of how fire can be beneficial as well as destructive to the environment.</i></p>	<p style="text-align: center;"><b>Range of Typical Student Responses</b></p> <p><i>Descriptors of grade-level-appropriate student responses:</i></p> <ul style="list-style-type: none"> <li><b>Full understanding</b> - explanation, and argument for how the evidence supports the explanation. Forest fires can be destructive and beneficial, based on the evidence collected. The evidence from the experiment supported the fact that high temperatures will kill/destroy microorganisms in the soil. According to the research, destructive crown fires will destroy the soil and larger organisms at extreme temperatures. Low-burning fires can be beneficial by clearing low-growing organisms and dead organic matter on the top of the soil, allowing for new growth and support of the ecosystem's food web. Land managers can develop plans to limit destructive fires to the ecosystem with this evidence.</li> <li><b>Partial understanding</b> - explanation only - "Forest fires can be beneficial and destructive. Forest fires can help the environment, or can hurt the environment and kill the plants and animals."</li> <li><b>Limited understanding</b> - information only - "We read that forest fires kill many of the animals and plants in the forest. Interestingly, forest fires can also kill fish in the water. We also saw that when we baked the soil, all of the living things in the soil were killed."</li> </ul>	<p style="text-align: center;"><b>Acting on Evidence of Learning</b></p> <p><i>Description of instruction action and response to support student learning.</i></p> <ul style="list-style-type: none"> <li>action for students who display partial or limited understanding -</li> <li>extensions of learning for students who display full understanding -</li> </ul>
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<i>SEP, CCC, DCI Featured in Lesson</i>	<b>Science Essentials</b> <i>(Student Performance Expectations From Appendix C, D, E)</i>
<b>Science Practices</b>	Plan and carry out an investigation to gather data and information about how changes to a system can be beneficial or destructive. Develop an argument to support an explanation for the causes of changes to a system.
Plan and carry out an investigation Develop an argument	
<b>Crosscutting Concepts</b>	Determine how changes to a system can result in more stable systems. Investigation of the changes to a system.
stability and change systems	
<b>Disciplinary Core Ideas</b>	• A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2), (HS-LS2-6)
<b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b>	

**Appendices:****Appendix A - Student Prompts for the Lesson -**

**Phenomenon:** *The forest in northern Arizona near Flagstaff “Camp” wildfire burn looks different since the fire.*

**Group Performances:**

1. Obtain information by watching videos to observe area changes before and after forest fires.
2. Develop questions to investigate changes to ecosystems caused by forest fires.

**Class Discussion about Good Questions to Investigate**

3. Obtain information about the effects of high temperatures from fires on soil ecosystems.
4. Plan and carry out an investigation to determine the effects of high temperatures on the living organisms in forest soil.  
(Materials - Soil, metal pie tin, oven, low power microscope, petri dish with nutrient agar.)

**Class Discussion about procedures and safety for the investigation**

5. Obtain information about changes in the forest ecosystem after fires.
6. Develop a model to show changes to a forest ecosystem caused by fire.
7. Construct an explanation for how wildfires cause changes to forest ecosystems.

**Class Discussion:**

8. Construct an explanation for how forest fires can be beneficial as well as destructive.

**Class Discussion****Individual Performances: Write SSW**

9. Develop an argument for how the evidence you gathered supports the explanation that forest fires can be beneficial as well as destructive.

*(Teaching Suggestions: Project only one of the performances at a time as you go through the lesson. You will need to discuss ideas like succession in the class discussion.)*

**Appendix B-1 Links for the Gathering Phase**

<i>Performance</i>	<i>Name</i>	<i>URL</i>
# 1	<i>Video: Kuark forest before and after the fires</i>	<a href="https://www.youtube.com/watch?v=E8QB6f5t_C8">https://www.youtube.com/watch?v=E8QB6f5t_C8</a>
	<i>Video: Fire and Water: Restoring Arizona's Forests</i>	<a href="https://youtu.be/DXauJ_cCB5w">https://youtu.be/DXauJ_cCB5w</a>
# 3	<i>PHC Film: Soil is a living organism</i>	<a href="https://www.youtube.com/watch?v=8ugaL6wsXME">https://www.youtube.com/watch?v=8ugaL6wsXME</a>
	<i>Article: Fire Effects on Soils - USDA Forest Service</i>	<a href="https://www.fs.fed.us/rm/boise/AWAE/labs/awae_flagstaff/publications/neary_fireeffectsonsoils.pdf">https://www.fs.fed.us/rm/boise/AWAE/labs/awae_flagstaff/publications/neary_fireeffectsonsoils.pdf</a>
# 6	<i>Video: How Fire Can Restore a Forest: A Time-Lapse (Tree View)</i>	<a href="https://www.youtube.com/watch?v=cMUnFyz_8mM">https://www.youtube.com/watch?v=cMUnFyz_8mM</a>
	<i>Article: The Ecological Benefits of Fire</i>	<a href="https://education.nationalgeographic.org/resource/ecological-benefits-fire">https://education.nationalgeographic.org/resource/ecological-benefits-fire</a>

### Appendix B-2 -

#### Fires Change Forest Ecosystems

Forests are biodiverse ecosystems that are home to many different species. While humans may view a wildfire as unnatural and harmful, fires are natural phenomena that have shaped forests for hundreds of years. Fires change both the living and nonliving components of an ecosystem.

Secondary succession occurs after disturbance that leaves the soil intact.

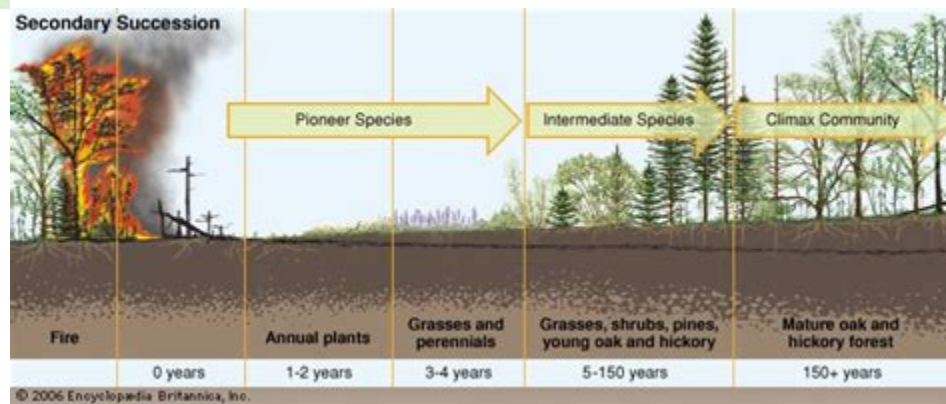


1988 fires in Yellowstone



Think of all the living parts (or biotic factors) in an ecosystem: the microbes and worms in the soil, the large trees throwing shade on the smaller plants below, the dead logs on the forest floor, and all the insects, birds, reptiles, and mammals in the forest food web. Likewise, nonliving components (or abiotic factors) in an ecosystem, such as the amount of precipitation (annual snow and rain), average temperature, and even the direction and speed of wind, can fluctuate year to year. This can impact the size and duration of forest fires. Human attitudes have also historically shaped how we address forest fires.

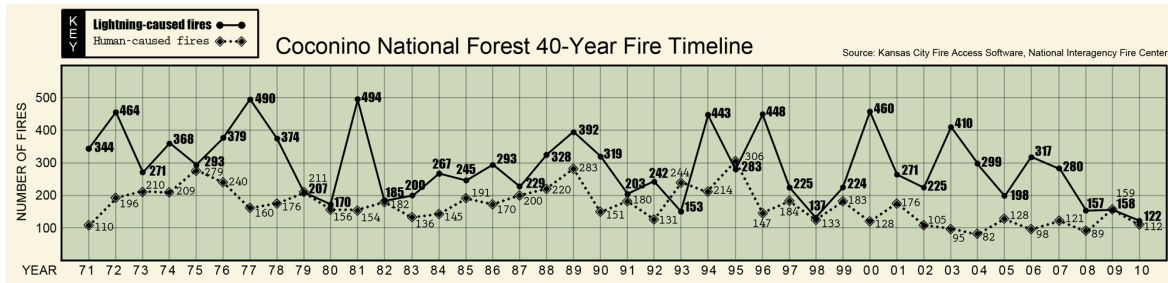
Over the past few decades, we have learned that small fires have an important role in the ecosystem, and they may harm the ecosystem if humans immediately try to extinguish every forest fire that crops up. Secondary succession can occur after a forest fire, and the amount of time it takes for the forest to recover will depend on how hot and how big the fire burns.



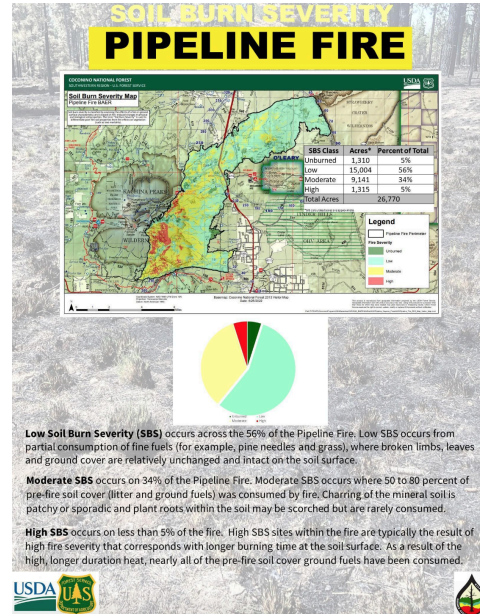
On June 12, 2022, a human-caused fire, the Pipeline Fire, began in Coconino National Forest, just north of Flagstaff, AZ. On June 13, 2022, another fire, the Haywire Fire, broke out just east of the Pipeline Fire. The recent fire in the area, on July 21, 2022, is the Committee Fire, which was reported on July 15, 2022, to have been caused by lightning.

The pipeline fire grew to cover 26,528 acres, and families had to evacuate their homes. After eight days, they were allowed to return. The Haywire Fire grew to 5,065 acres, and people were instructed to evacuate. The evacuations were lifted on July 13, 2022. The Committee Fire grew to 300 acres. Families have not been told to evacuate the area but should remain “ready.”

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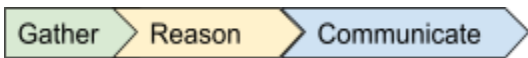


There are many benefits from forest fires, including clearing out dead organic material to allow for new growth and access to nutrients, increasing the fertility of the soil by releasing nutrients back into the soil, and several plants require fire for their life cycle (certain pine trees to open pine cones, types of lilies for seed germination), getting rid of invasive species (bark beetle, pitch canker), and aiding in the forest food web by allowing plants that provide food to primary consumer animals that then trickle up to higher food levels.



The clearing of the undergrowth and lower branches caused by a fire will allow more sunlight to enter below the forest canopy and allow new germination of different species of plants. This will allow surviving smaller plants to have less competition for sunlight and nutrients (water; minerals) and increase the population of these smaller grasses, herbs, and shrubs.





## Template for Developing GRC Lessons Aligned to Three-Dimensional Science Standard

### *Appendix C- 1*

### *Appendix C- 2 Scaffold for Student Argument*

***Explanation***

Construct an explanation for how forest fires can be beneficial as well as destructive.

***Lines of Evidence -***

Evidence from the investigation.

Evidence from the research (videos and articles).

Evidence from the class discussion.

Evidence from other sources.

***Argument***

Develop an argument for how the evidence you gathered supports the explanation that forest fires can be beneficial as well as destructive.