Fire Ecology Learning Lab
Agency and Informal Educator Lesson Plan: Fire Behavior and/or Conservation Careers

Grade Level: High School
Estimated Time per Class: 50 Minutes Total (for Fire Behavior only)

- Arrive 30-45 minutes before lesson to check in, find the room, and set up materials
- Plan for 15 minutes after lesson to clean up materials
- Additional time at your office to prepare materials, print, and communicate with teacher

Lesson Overview:

- 10 minutes - Opening Activities
- 30 minutes - Experiment
- 10 minutes - Closing

Alternate or Extended Lesson: Included is a presentation template about conservation careers and a personality quiz to help students identify careers that are a good fit. These can be added to the Fire Behavior lesson for an extended lesson to fit a lab period, used on their own, or included along with a Q&A if requested by the teacher.

Note: Fire Behavior portion adapted from the FireWorks Matchstick Forest, www.frames.gov/fireworks/home.

Student Materials	Teacher or Whole Class Materials
• Goggles • Sterilizing wipes (if you will see more than one class you will need to clean goggles) • Experiment design worksheet • Pencil (ask teachers to provide) • Science notebooks or clipboards (ask teachers to provide) • *Optional*: phones or tablets to record the way the models burn	• Teacher letter, draft provided in binder • Parent letter, draft provided in binder • Square MDF boards (bases for the forest) • Forest over the years pictures (available as PPT and physical cards) • Matches (double check, they will need to be replenished over time) • Fire extinguisher • Spray bottle • Water buckets

	Careers ● Career Presentation Template (presenter must fill in template before classroom visit; available online) ● Career Personality Quiz handout, printed for number of students (original included in binder and available online)

Guiding Questions, Goals, and Objectives

<u>Guiding Questions</u>

Fire Behavior

- What are the key factors that affect fire behavior during wildfires?

Careers

- What careers are available in wildland fire and natural resources? What education and experience are needed to access these jobs?
- What are your primary personality types? What careers might be a good fit for you?

<u>Goals - Careers</u>

- Students will learn first-hand, authentically, and in-depth about the education and career experiences of a wildland fire professional.
- Students will make connections between their primary personality types and jobs tied to wildland fire and natural resources.
- Students will know what fire is and how different jobs in wildland fire play a role in its science and management.

<u>Objectives - Careers</u>

- 90% of students will know that there are a variety of careers in natural resources and fire.
- 80% of students will be able to identify their primary personality types.
- 70% of students will have ideas for what kinds of natural resources careers fit with their primary personality types.
- 50% of students will be able to explain how the fire behavior model connects to the presenter's job.

Vocabulary	
• **Convection** – Heat transfer method where energy is transferred through molecular motion • **Conduction** – Heat transfer method where energy is transferred by direct contact • **Radiation** – Heat transferred method where energy is transferred by electromagnetic waves	• **Fuel load** – the total amount of combustible material in a defined space • **Fuel** – material (like wood, leaves, coal, or gas) that releases energy (such as light, heat, or power) by being burned • **Topography** – physical features or characteristics of a land surface, including its elevation, contours, and the distribution of natural and artificial features

Agenda and Timing	Notes
Prepare: • *At least 2 weeks before*: send letter for teacher to provide to families about trauma informed approach, provided in binder • *1 week before:* Contact teacher to confirm details • Collect and prepare materials • Arrive at least 30-45 minutes before the lesson is supposed to begin • Set up outside (fire safety) and inside (pre-designed matchstick forest) • Lay out all handouts somewhere they are easy to reach for each part of the lesson	**Before visit:** • Ensure the teacher has informed school administration of the lesson and receive permission to burn material on the school grounds • Confirm that the teacher has checked in with families to identify any students who might have been impacted by fire, in line with trauma-informed approach • Discuss safety protocols. Ensure there is water nearby • Confirm the location of the burn • Make copies of handouts, including in class worksheets and homework, for each student. • Set up matchstick forest (setup details at the end of lesson)

Timing and Instructions Opening Activities (10 minutes)	Notes
5 minutes ● Introduce yourself and your agency, give a brief explanation of how you started in this field (education, experience, interests) and what you usually do in a day ● Show students the matchstick forest ● Ask them to make a hypothesis of how it will burn 5 minutes ● Outside or in a fume hood, light the matchstick forest as instructed at the end of the lesson. ● Pair share about if the 'forest' burned as expected	Have the matchstick forest ready before the beginning of class. Placing the matches can take more time than imagined, so plan accordingly 

Timing and Instructions Experiment (30 minutes)	Notes
5 minutes ● Introduce the Fire Behavior triangle ● Students should use observations from the first forest to inform the Triangle 5 Minutes ● Introduce the experiment ○ Each group will get a card with instructions for a basic experiment building their own matchstick forest ○ The card will describe the variable that should be changed within each group, but students decide what the change looks like in their experiment ● Hand out a worksheet to everyone and one experiment card to each lab group. 5 minutes ● Students build their experiment 15 minutes ● Burn all experimental matchstick forests (one by one, or all together depending on time) ● Have students record what they observe	Hand out materials just before introducing the experiment. Each group should get one MDF board and a box of matches (they will not use all; 50 matches per forest) and an experimental design card. Start with some of the more basic experiments; for instance, show and talk about density before slope and weather.

Timing and Instructions Closing (10 minutes)	Notes
5 minutes ● Show the images of ponderosa pine forests through the years showing how absence of fire has led to increased fuel loads. This is available as a PowerPoint or as printed pages if a projector is not available. ● Have a short discussion about how this connects with the models you burned. Identify which models align with the different forest images. ● Emphasize: This is the SAME view of the SAME forest. How has it changed? This is due to humans suppressing fires for a century. 5 minutes ● Hand out green jobs personality quiz worksheet or link to online version, mentioning the importance of conservation jobs and how the survey can help students connect their interests with careers. ● Discuss heat transfer methods question (if desired by teacher). If Timing allows: ● Deliver career presentation and/or facilitate a Q&A about your career and career path.	If the teacher desires the Heat Transfer Homework and there is extra time, it may be important to discuss the Heat transfer methods: Convection – flow of heat from the source to an object by way of a gas or liquid (Holding your hand above a candle without touching the flame) Conduction – Direct flow of heat from physical contact (a flaming front contacting a tree) Radiation – Transfer of heat without a medium of gas or liquid. Heat is transferred by electromagnetic waves (sunlight heating earth; or embers igniting fuels while being carried by the wind) A diagram is shown at the end of the presentation and on the student handout. Sharing your own experiences honestly is a good way to connect with students. Also, feel free to discuss career opportunities that differ from your own but align with a student's interests or some of the partners you work with.

Post-Lesson Activities and Homework	Notes
20 minutes: ● On the back side of the experiment worksheet, students write about climate change and how the heat transfer methods play a role in the different aspects of the Fire Behavior Triangle, in the final reflection question. ● Green jobs personality quiz worksheet pr online quiz can help students explore conservation careers.	Discuss with the teacher beforehand if they wish to assign the homework that accompanies this lesson.

Common Questions

- Are fires bad? *or* Aren't all fires bad?
  - Fire isn't good or bad on its own. Fires can be dangerous if they are burning near human habitation. Many landscapes, like grasslands and some forest types, are adapted to burning. Other ecosystems can be damaged if they burn. It is important to remember that fires have always been a part of the landscape. In many locations, people have used fire to clear areas for croplands, improve the health of vegetation to benefit people and wildlife, and for ceremonial uses. These practices by Indigenous peoples continue today and are often called "cultural burning."
- Is your job scary?
- How did you get your job?
- How much do you get paid? (Answer with a salary range, not an exact number.)
- How does climate change affect how fires burn?
- Be ready for questions about prescribed burns, especially in New Mexico.

Working with High School Classes

Tips and Tricks:

- Confirm with the teacher that you expect them to intervene with any behavior issues.
- Remember you are a subject expert. Avoid using acronyms and big words. Students (and even teachers!) will be unlikely to tell you they are confused.
- Your teacher might want you to visit multiple classes in a day. You might need to shorten or lengthen parts of this lesson to fit into their schedule.
- High school students like being treated like adults. They are beginning to decide their next steps in life as adulthood inches closer, so be prepared for questions about your job.
- Give them some space to make choices and share their thoughts. They can make complex connections.
- Set clear expectations and know you will need to repeat these. Expectations that you should share include that students should listen to you and one another, safety protocols, and other behaviors.
- Set clear consequences for not listening or not following directions, especially when doing the fire. Follow these consequences immediately. Consequences should include having students move groups or even being sent inside if there is a safety concern.
- Don't try to talk over students. Lower your voice and wait.

The state standards below are provided to share with teachers. These are topics they are responsible for covering in a year. By sharing these with teachers they will be more likely to justify having you visit their classroom. NGSS stands for Next Generation Science Standards. These are used in New Mexico, sometimes called STEM Ready! Science Standards. Arizona standards are similar but have a slightly different numbering convention. Both are included below. The lesson plan follows the "5E" model of instruction - Engage, Explore, Explain, Elaborate, Evaluate.

Next Generation Science Standards (NGSS) and AZ Science Standards	Related Learning Goals
NGSS HS-PS3-4 Energy: Plan and investigate to provide evidence that the transfer of thermal energy when two components of different temperatures are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).	Have students explain that there is a transfer of energy in a fire, converting stored carbon bonds to heat and light. This occurs through chemical reactions, triggered by convection, conductions, and radiation.
HS-LS2-6 Ecosystems: Interactions, Energy, and Dynamics: Evaluate the 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.	By altering the natural burning cycles of fire, humans imbalanced the ponderosa pine forest ecosystems. This can be seen in the ponderosa timeline photos.
AZ Science Standards Essential HS.E1U3.14: Engage in argument from evidence about the availability of natural resources, the occurrence of natural hazards, changes in climate, and human activity and how they influence each other.	By altering the natural burning cycles of fire, humans imbalanced the ponderosa pine forest ecosystems. This can be seen in the ponderosa timeline photos.
Essential HS.L2U3.18: Obtain, evaluate, and communicate about the positive and negative ethical, social, economic, and political implications of human activity on the biodiversity of an ecosystem. Essential HS.L2U1.19: Develop and use models that show how changes in the transfer of matter and energy within an ecosystem and interactions between species may affect organisms and their environment.	By allowing too much energy to be stored in trees and other plants (in carbon bonds), there is an increased fire risk that can impact the larger ecosystem. Frequent fires reduce this fuel load, allowing for a stable environment. This can be seen when investigating the models and looking at the images of the ponderosa forest over time.

Heat Transfer Diagram: