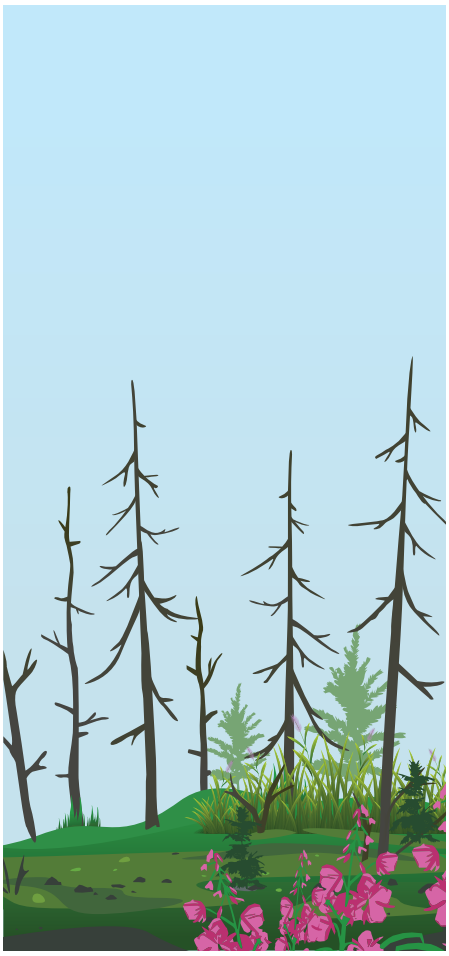
Wildfire
and Change in Alaska



FIRE & ICE

Alaska EPSCoR

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BACKGROUND INFORMATION ON WILDFIRES IN ALASKA

THE FIRE CYCLE[1]

As Alaska's lands developed from rock and ice into rich ecosystems, wildfire was an important part of the cycles of emergence, growth, and change in the natural world. When humans began to have an impact on the environment, fire was one of the ways we negotiated the landscape, using it to warm themselves, cook, make tools, and harvest. As we became more proficient in tool use, we were able to control wildfire on a larger scale, putting out and preventing bigger fires. However, as ecological conditions in Alaska are shifting, so are our practices. Fire scientists and land managers are learning to include wildfire as part of the many systems that play a role in the health of the land.[2] Fire is now becoming understood as a tool for maintaining healthy ecosystems, rather than as a threat.

The fire cycle is recognized by scientists, forest managers, and people who depend on the land as an important function of healthy forests. In the early days of institutionally managed forests, policies across North America required that fires be strictly controlled and put out as soon as possible. After years of fire suppression, forestry managers began to realize that the biggest fires happened in places where there were large amounts of fuel. In some cases, fire suppression policies were setting the stage for large, very destructive fires in places where people had hoped to prevent fire. The Yellowstone fires in 1988 were a prominent example of this lesson. Updated forest management policies now use prescribed burns and allow fires to burn as part of their practices, but fire suppression is still a widespread tactic. This series of lessons will help students understand that fires are an important part of healthy ecosystems.

THE FIRE TRIANGLE

Fire is a rapid chemical reaction that combines fuel and oxygen to produce heat and light. An external source of heat is usually required to start the reaction. Once the fire has started, it produces the heat it needs to continue burning. There are three components needed to start a fire: *fuel, oxygen,* and *heat*. This is called a *fire triangle*. If any one of the components is missing, a fire cannot occur.

A fuel is anything that will burn in a fire. In a forest surface fuels lie on or right above the ground; surface fuels can be leaves, grass, dead wood, partially decomposed plants, stumps, or brush. Ground fuels lie beneath the ground surface. The organic layer of soil consisting of decaying leaves, roots, or other plant material makes up much of the ground fuel. Canopy fuels include tree branches and leaves, dead standing trees, hanging beard lichens, and high brush. Oxygen is found in

the air. The amount of fresh oxygen available to a fire is often influenced by the wind. Compare this to making a campfire. What happens when you blow on the fire? Wind also helps the fire by blowing the heat towards more fuel, moving the fire by carrying sparks, and drying out the fuel through evaporation. Heat is provided by nature in the form of lightning or volcanoes. In interior Alaska, lightning starts many fires. Matches, campfires, and cigarettes are often the sources of heat in many human-caused fires.

To stop a fire, the triangle must be broken. To slow down a fire, one of the three components of the triangle must be changed. Think about ways that large and small fires are controlled. One way to remove heat is to throw water onto a fire — the water absorbs heat and also cuts off oxygen. You could stop the flow of oxygen by throwing dirt on the fire, using a fire extinguisher, or dropping fire retardant from planes. The fuel supply could be removed by building a fire line around the fire.

ALASKA'S ECOSYSTEMS AND WILDFIRE[3]

Natural fire frequency in Alaska is diverse and depends on region, site characteristics, and vegetation. Alaska's boreal forests burn naturally every 25 to 300 years, while on the Alaskan tundra natural fire frequency is much more infrequent and ranges from 175 to 1,000 years.

Plant succession takes place after a fire, meaning smaller plants like grass begin growing before giving way to shrubs and then, eventually, trees again. To maintain ecological diversity, Alaska's plant and animal communities are highly dependent on fire regimes.

Plants and animals affect the occurrence of fires. Fires could not occur if not for the fuel provided by the growth and accumulation of plant materials (wood, branches, dead leaves and stems, and dead mosses). These accumulated fuels decompose slowly due to cool soil temperatures. The mix of plant species also influences the extent and intensity of fires due to variation in growth forms and chemical composition.

Animal activities may also affect the occurrence of fire. For example, outbreaks of certain insects such as bark beetles can kill hundreds of trees and create optimum conditions for a fire to start and spread. Beavers help to prevent the spread of fires by creating large ponds that act as fire breaks; conversely, they enhance the chances of fire by injuring and killing trees which then provide more available fuel. Large piles of spruce cone bracts created by red squirrels provide sources of dry fuel. Animals may also influence the types and density of plants that occur, which in turn, affects the occurrence of fire. In some cases, intensive browsing of shrubs and saplings by moose and hares may slow the rate of plant succession. Thus, the frequencies and intensities of forest and tundra fires may be influenced by the animals, as well as by the plants and physical conditions of these environments.

FIRE BEHAVIOR[4]

Fire behavior is the term used to describe the way a forest fire moves. It includes the many different characteristics a fire can have. Factors that influence fire behavior include weather, time of year, time of day, climate, tree density, and landscape. Human structures (like roads and houses) also affect the way a fire spreads through an area.

Firefighters use specific language to talk about fires and firefighting. *Prescribed burns* are fires that are intentionally set in order to maintain a certain type of vegetation or ground cover. A *backburn* is a fire that is intentionally set in order to eventually join another larger fire that is threatening to burn out of control. A *fireline* is a row of firefighters working to control a fire. A *firebreak* is a space that has been cleared of anything that can burn.

Rivers and roads can make firebreaks, and people create margins of safety, or *defensible spaces*, around houses and other buildings. Wind fans flames, and fires burn faster uphill. Rocky ground may have a lighter plant density. South-facing slopes may be drier and hotter than North-facing slopes at the same elevation. Wetlands burn very differently than a dry grassland. Fire scientists have to keep all of these things and more in mind when they make decisions about how to approach a fire.

CURRICULUM STANDARDS

This curriculum is built specifically for Alaskan environments and students, focusing on Alaskan geography and ecosystems. It follows the Content and Performance Standards for Alaska Students and is designed to meet the Science Standards for Alaska, which in turn, are based on the Next Generation Science Standards (NGSS). The methods for drawing out student ideas come from ambitiousscienceteaching.org.

Science Standards for Alaska

There are seven Crosscutting Concepts that the NGSS touch upon throughout the course of a K-12 career. This curriculum focuses primarily on "Systems and system models;" "Cause and effect;" and "Stability and change."

There are also eight Science and Engineering Practices in the NGSS. This curriculum utilizes "Developing and using models" as a main focus, however, "Analyzing and interpreting data;" "Constructing explanations and designing solutions;" "Engaging in argument from evidence;" and "Obtaining, evaluating, and communicating information" are also used.

Specific Disciplinary Core Ideas and content standards addressed:

Third Grade

3. Inheritance and Variation of Traits: Life Cycles and Traits

3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment.

3. Interdependent Relationships in Ecosystems: Environmental Impacts on Organisms

3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

3. Weather and Climate

3-ESS3-1 Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

3-5. Engineering Design

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Fourth Grade

4. Energy

4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4. Earth and Human Activity (NGSS only)

4-ESS3-1 Obtain and combine information that energy and fuels are derived from natural resources and their uses affect the environment.

4. Structure, Function, and Information Processing

4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

4. Earth's Systems: Processes that Shape the Earth

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

Fifth Grade

5. Structure and Properties of Matter

5-PS1-1 Develop and use a model to describe that matter is made of particles too small to be seen.

5. Earth's Systems

5-ESS2-1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere (water), cryosphere (ice), and/or atmosphere interact.

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

Alaska Content and Performance Standards:

Geography:

A. A student should be able to make and use maps, globes, and graphs to gather, analyze, and report spatial (geographic) information. (A-2, A-4, A-5, A-6)

B. A student should be able to utilize, analyze, and explain information about the human and physical features of places and regions. (B-8)

C. A student should understand the dynamic and interactive natural forces that shape the Earth's environments. (C-1, C-2, C-3)

E. A student should understand and be able to evaluate how humans and physical environments interact. (E-5, E-6)

F. A student should be able to use geography to understand the world by interpreting the past, knowing the present, and preparing for the future. (F-2, F-3)

Arts:

A. A student should be able to imagine and develop artistic ideas and work. (A-2)

Library and Information Literacy:

D. A student should be aware of the freedom to seek information and possess the confidence to pursue information needs beyond immediately available sources. (D-5)

Cultural Standards:

A. Culturally-knowledgeable students are well grounded in the cultural heritage and traditions of their community. (A-4)

B. Culturally-knowledgeable students are able to build on the knowledge and skills of the local cultural community as a foundation from which to achieve personal and academic success throughout life. (B-1)

C. Culturally-knowledgeable students are able to actively participate in various cultural environments. (C-3)

D. Culturally-knowledgeable students are able to engage effectively in learning activities that are based on traditional ways of knowing and learning. (D-4)

E. Culturally-knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interaction of all elements in the world around them. (E-1, E-2)

NOTES AND ADDITIONAL REFERENCES

1 The fire ecology information is adapted from "Fire In Alaska K-12 Curriculum Guide, Revised 2007"

2 Clark, R. (2016). Scanning the future of wildfire: Resilience ahead... Whether we like it or not? Fire Science Digest, 22, 16.

3 (Adapted from smokeybear.com) For background reading about natural fire cycles: https://smokeybear.com/en/about-wildland-fire/benefits-of-fire/fire-in-nature

4 Adapted from NPS Article: "Wildland Fire — Learning in Depth" Chapter 12: Wildland Fire Behavior https://www.nps.gov/articles/wildland-fire-behavior.htm#:~:text=The%20Fire%20Behavior%20Triangle,and%20their%20influence%20on%20fire.

For background reading about fire in Yellowstone, an excellent case study:
https://www.yellowstonenationalparklodges.com/connect/yellowstone-hot-spot/the-value-of-fires-to-yellowstone-national-park/

Wildfire reference page:
https://www.nps.gov/articles/series.htm?id=ED398874-1DD8-B71B-0B594AA554EB0E8C

Fire behavior triangle:
https://www.nps.gov/articles/wildland-fire-behavior.htm

Fire behavior video:
https://www.youtube.com/watch?v=SB4pk91yq24

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LESSON #1:
THE FIRE CYCLE

GRADES:
3-5

TIME REQUIREMENT:
20-40 minutes, depending upon assessment activity

STANDARDS:
Science Standards for Alaska and NGSS:
5-ESS2-1

Alaska Content and Performance Standards:
Geography: A-4, B-8, C-2, C-3, F-2
Alaska Cultural Standards:
B-1, D-4*, E-2
** D-4 is addressed if an elder (or knowledge bearer) is invited to the classroom to share stories of wildfires in the area.*

OVERVIEW:

Forest fires are part of a naturally-occurring cycle, and humans can both influence and be influenced by it. This lesson describes the cycle stages and asks students to describe and think about them.

BACKGROUND INFORMATION:

The fire cycle is recognized as an important function of healthy forests by scientists, forest managers, and people who depend upon the land. After years of fire suppression, forestry managers began to realize that the biggest fires happened in places where there were large amounts of fuel. Updated forest management practices now use prescribed burns and allow fires to burn, but fire suppression is still a widespread tactic. This lesson will help students understand that fires are an important part of healthy ecosystems.

PEDAGOGY NOTES

This lesson uses storytelling to cover a big concept. There are many opportunities for creating and recreating the story (writing, drawing, acting) for both teachers and students, so feel free to adjust the lesson to the learners' needs.

CONSIDERATIONS:

Fire can be a traumatic topic for students, so be prepared to take the time to address student concerns and safety. Acknowledging students' experiences and understandings will be important; some students may have very strong feelings about fire, fire suppression, etc. The lesson begins by asking students what they know about forest fires. When fire is recent, students might have a lot to share. In this case, consider preparing students for the lesson by asking them to draw or write a story about their experiences with forest fire.

MATERIALS NEEDED

- Wildfire cycle cards
- Story script
- Fire cycle illustration

LEARNING OBJECTIVES

At the end of the lessons, students will be able to:

1. Model the fire cycle using cards, explaining their reasoning for the sequencing of the stages.

2. Identify and describe different stages of the wildfire cycle.

3. Identify and describe changes in the forest habitat from stage to stage in the cycle.

ASSESSMENT

1. Students arrange the cards in a fire cycle and are able to explain why one card precedes or follows another using the story.

2. If students arrange the cards in a sequence that differs from the one in the story or illustration, they are able to explain why they chose the sequence they did.

3. Students write a story of the cycle, using the key stages -or- describe the passage between two stages of the cycle, focusing on the changes that occur and the reasons for these changes.

ACTIVITY STEPS

1. **Opening discussion**
   Ask students what they know about forests. Lead into what they know about forest fires.

2. **Cue students for a story**
   If they are used to hearing stories, the following introduction may not be necessary.

   "I'm going to tell a story, and I'm going to ask you to use your imaginations. This story begins and ends with a forest."

3. Read the story slowly enough that the students can attach the story to the images. If the students are younger, consider adding motions and having them make sound effects at key places in the story.

(Note: this is for the Boreal forests around Fairbanks, details could be changed to make it appropriate for other ecosystems.)

4. **Read the story script** *(separate page)*

5. **Lead a discussion about cycles**

   - What do you think happens next?
   - Do you think this story ends here?

   Explain that forest fires are a part of the cycles that forests go through. Include the ideas of repetition and variation in cycles.

6. **Have the students recreate the story using the cards.**
   Consider reading the story again as the students arrange the cards. The cards should form a circle, where the two forests meet. One way to do this is to hand the cards out to the students and ask them to physically arrange themselves in the sequence of the fire cycle, displaying their cards to the whole group. Students representing different stages should explain their relationship to the stages preceding and following theirs.

7. Ask the students to compare their arrangement of the cards to the illustration. Ask them to note any differences between the two arrangements and explain their reasoning.

8. **Concluding discussion:**
   - Humans sometimes start forest fires and sometimes put out forest fires. How does this affect the fire cycle?
   - What other things do humans do that can affect the fire cycle (ie. hunt, cut trees, plant gardens, clear land)?
   - What changes in the forest could affect the fire cycle?

EXTENSION

Additional science standards are addressed by including activities and discussions that explore plant and animal adaptations for survival in a changing environment.

- Draw a plant that is able to survive a forest fire. What does it need to survive? **(3-LS3-2; 3-LS4-4; 4-LS1-1)**
- Draw a picture showing how the habitat after a forest fire is different than the habitat in a forest before the fire? Draw animals do you think would thrive in the habitat before a fire and show what they have that allows them to survive. Do the same for the habitat after. **(3-LS3-2; 3-LS4-3)**
- Do you think that a forest fire might be a good way to create new habitat for certain animals? Why or why not? **(3-LS4-4)**

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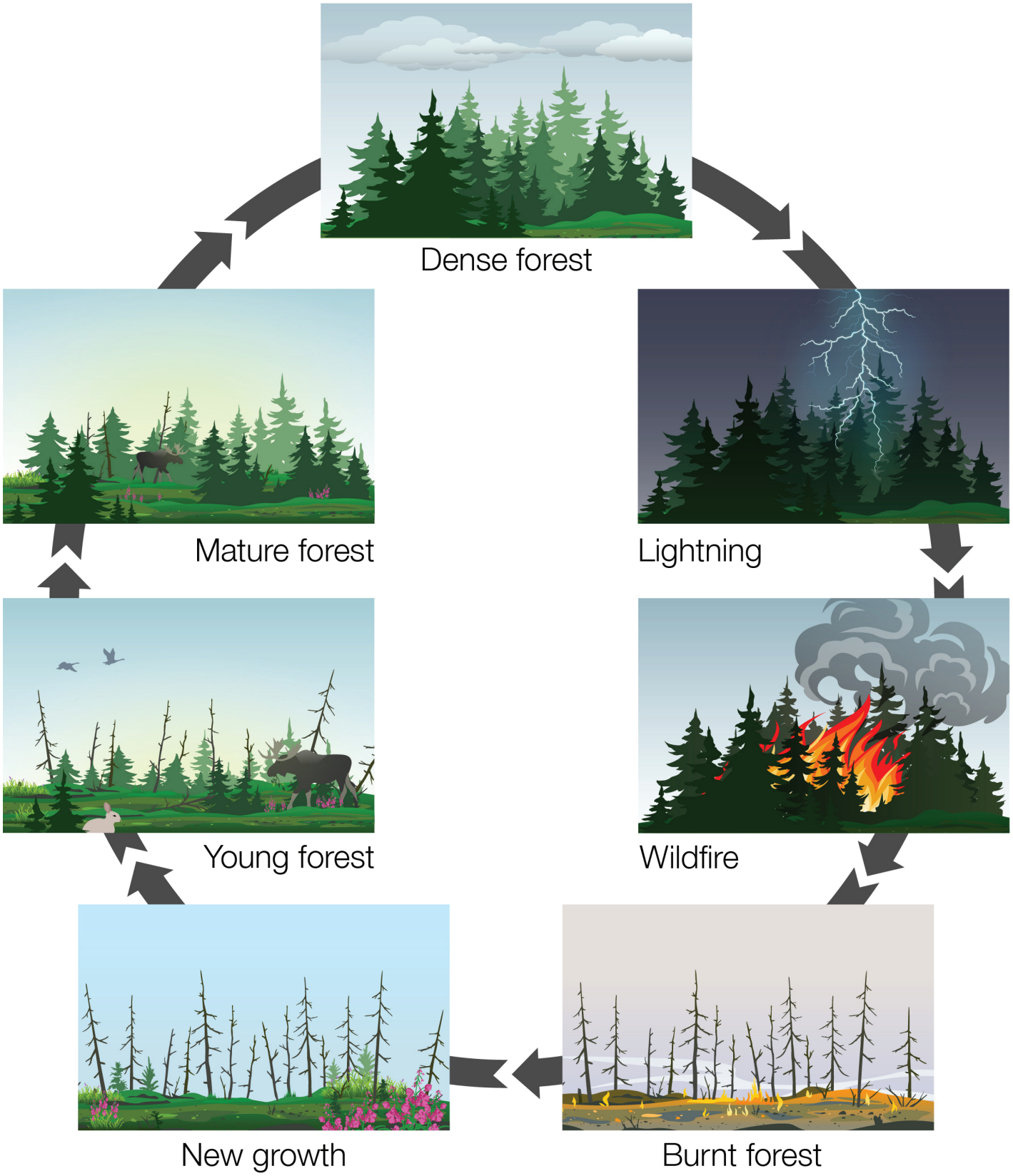
The Fire Cycle



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DENSE FOREST

UAF Design Services illustration, includes elements from dgim-studio | freepik.com, Oceloti | dreamstime.com and downloadfreevector.com

LIGHTNING

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WILDFIRE

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BURNT FOREST

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NEW GROWTH

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YOUNG FOREST

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MATURE FOREST

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THE FIRE CYCLE STORY SCRIPT

You will need the seven photographs that accompany this story. There are prompts in the story for when to show them.

I'm going to tell you a story, one that begins and ends with a forest. ***Show picture of an Alaskan boreal forest.***

Imagine a forest, one like you see here. Maybe you've seen one like it. The trees are tall and they grow together to make a shady canopy. In the winter the snow sticks to their branches, especially the spruce trees. And then spring comes, and the sun is shining longer during the day. A lot of the trees put out their green leaves, and the snow melts, exposing the dead logs on the forest floor. New bushes and grasses push up. Imagine all the plants stretching up to the sun. It's summer now, and it's getting hotter out...and now the snow is gone, and it's dry enough to walk around under the trees.

Then one day the wind comes up, and a storm rolls across the sky. There are lots of clouds. There's thunder, and there's lightning jumping from cloud to cloud. ***Show picture of lightning.***

Some of this lightning goes down to the forest and hits trees, and some of those trees catch on fire. And the trees next to them catch on fire. And the trees next to those trees catch on fire. And soon a big part of the forest is on fire. ***Show picture of a forest fire.***

After a while the forest is burnt away. Maybe the rain falls and stops the fire. Maybe there are no more trees left to burn. Ashes and burnt logs lie all around. ***Show picture of a burnt forest.***

The days pass and the seasons continue. Soon, tender green shoots are poking up through the ground, and before long there are young plants growing. Some of these plants are young trees just like the ones that burned, and some are new plants that weren't there before. ***Show a picture of new growth.***

All these plants grow and become bigger, creating a young forest. Animals come to eat the tender leaves, flowers, and berries that they can reach. ***Show picture of a young forest.***

As the forest gets older, the plants change, and it shifts more towards trees. As these trees grow, they drop dead limbs and the forest gets denser, crowding out the light for the smaller plants. ***Show a picture of a darker, denser forest.***

What do you think happens next?

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LESSON #2:
THE FIRE TRIANGLE

GRADES:
3-5

TIME REQUIREMENT:
45-60 minutes

STANDARDS:
Science Standards for Alaska and NGSS:
4-PS3-2, 4-ESS3-1

Alaska Content and Performance Standards:
Geography: C-1, C-2
Arts: A-2
Alaska Cultural Standards: B-1

OVERVIEW:

In order to burn, fires need the available parts of the fire triangle—*fuel, oxygen,* and *heat*. This lesson highlights each of the three parts.

BACKGROUND INFORMATION:

Fire is a rapid chemical reaction that combines fuel and oxygen to produce heat and light. Fire experts use the fire triangle as a way to focus on each of the three components needed for a fire. To stop, start, or slow down a fire, one of the three components of the triangle must be changed. Heat is sometimes referred to as *ignition*; it is the rapid transfer of energy that starts the chemical reaction. In interior Alaska the heat energy usually comes from lightning or human activity (match for a campfire, sparks from an ATV, cigarettes). In the wild, fuels are readily available as leaves, grass, dead wood, roots, partially decomposed plants, stumps, or brush both above and below the ground. Oxygen is affected by wind, rain, dirt, or anything that increases or decreases its availability. This lesson focuses on each of the three parts of the fire triangle individually, but only when they are together in the right ratio will they become fire.

CONSIDERATIONS:

This lesson uses video demonstrations. If you decide to do these demonstrations yourself, be sure to take safety precautions and discuss them with the students.

MATERIALS NEEDED

- Demonstration videos (Oxygen and Heat/ Fuel)
- Sticky notes (and space to post them)
- Illustration of the fire triangle
- Fire Triangle Template sheets

LEARNING OBJECTIVES

The student will:

1. Identify that oxygen, ignition and fuel are all needed to produce and maintain fire
2. Identify heat or ignition sources as points of energy transfer
3. Create a model of the fire triangle

ASSESSMENT

1. Student's answers in class discussion. Do they understand that:
    - All three elements must be present for a fire to occur?
    - The heat is a form of energy being transferred?
2. The observations that students put in each triangle section

ACTIVITY STEPS

1. **Opening discussion**
   Ask students if they have ever seen a wood stove or campfire and have them explain what they have seen and noticed. Draw out the idea that heat and light are forms of energy. Tell the students that you are going to demonstrate specific parts of a fire.

2. **Oxygen demonstration**
   A. Show the "Oxygen" video: https://www.youtube.com/watch?v=5AOp8Tfvlbo&list=PLk6lIYH-I4WDteQ7YfkF6o_KinT81eQZ2&index=1

   B. Ask the students to think to themselves, "What happened in each case? What was different? What was the same?"

   C. Write the questions on the board and show the video.

   D. Ask the students to pair up and share what they observed in each case. Show the video again if needed.

   E. Lead a short class discussion focusing on observations. Redirect any

inferences or talk that leads away from observations. At some point wrap up the discussion by stating "So we all noticed that both candles went out. What were the steps leading up to each candle going out?"

F. Solicit student ideas and help them focus on the fact that the flame stopped burning in each case. Now ask the student pairs to make a claim about why they think the flame went out. Ask each student pair to write their answer on a sticky note.

WRITING PROMPT:
"We think the flames stopped burning because _____."

G. Post the sticky notes on a wall and review them as a class. Group similar theories and ideas.

3. Heat demonstration

A. Show the "Heat/Fuel" video and pause at the prompt at 0:12: https://www.youtube.com/watch?v=GheKNRajRJo&t=18s

B. Ask the students if the matches are burning ("Is there is a flame?"). Have them pair-share to explain why the matches are not burning and what is needed for the matches to burn ("What's missing? What needs to happen?"). Each team writes their answers on a sticky note.

WRITING PROMPT:
"We think that the matches are not burning because _____. "_____ needs to happen for the matches to burn."

C. Post the sticky notes on a wall and review them as a class. Group similar theories and ideas.

Pedagogy Note: *The idea is to begin discussing the idea that some kind of energy must be present, whether it is heat from friction, or the heat from a flame. A good vocabulary word to introduce at this point is ignition.*

4. Fuel demonstration

A. Prepare to resume the video by telling the students that the matches will be

lit. Ask the students to predict what is going to happen by pair-sharing:

Will the matches both burn the same way? Will one match burn more than the other? Why / why not?

B. Resume the video.

C. Ask the students to pair share:

Was there any difference in how the matches burned? If yes, what is the explanation for that difference?

D. Resume the video. It will repeat the demonstration with new matches.

E. Now ask the students to consider:

What happened to the wood of the matches when they burned? Ask each pair of students to write their answer to the prompt on a sticky note.

WRITING PROMPT:
"We think that the wood from matches turned into _____."

F. Post the sticky notes on a wall and review them as a class. Group similar theories and ideas.

Pedagogy Note: *At this point the students should be ready to discuss energy showing up as heat or fire.*

5. Fire triangle

A. Review the theories and ideas generated in the three demonstrations / activities.

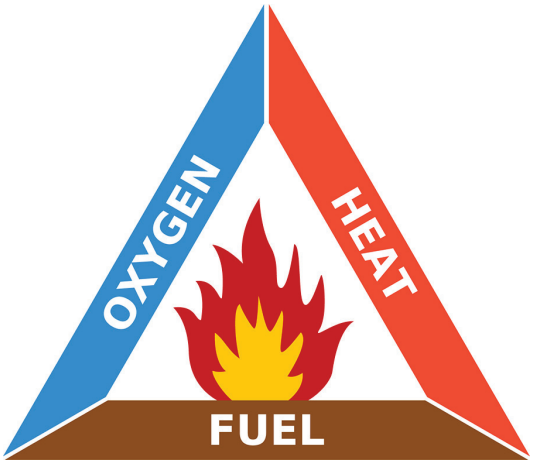
B. Now introduce the fire triangle. Explain that each demonstration focused on one part of the fire triangle and that all three things must be present in order for a fire to be present. Identify each part of the fire triangle in the demonstration and point it out.

Pedagogy Note: *Oxygen is always present, so we might talk about some ways that the match could be extinguished (water, sand, blowing) and how these interfere with Oxygen.*

6. Describe the Fire Triangle

A. Hand out the template sheets and ask students to label the sides of the triangle according to the diagram.

B. Have them draw or write a description of what they observed for each side of the triangle and then explain why they drew or wrote.



credit: wikimedia | Gustavb

EXTENSION

Divide the students into groups of 3-4. Have them use the attached template and label each side of the triangle with one aspect of the fire triangle. Explain that they are going to apply the fire triangle to different situations.

Model the activity using the Fuel demonstration from the Heat/Fuel video. In the central triangle write "Fuel Demonstration" (or any other name that you used). In the section corresponding to 'Fuel', write "The wood/ paper of the matches". In the section corresponding to 'Heat', write "The friction on the match head" -or- "The heat from the flame", depending upon how you ignited the matches. In the section corresponding to 'Oxygen', write "The air in the room".

Have the students do the same using different settings. They could also draw the different examples. A series of suggested settings with corresponding examples is below.

Setting	**Oxygen**	**Heat**	**Fuel**
Forest fire	Air in the forest Wind	Lightning Cigarette butt	Trees Leaves
"Oxygen" video demonstration	Air in the room No air in jar	Match used to light candle	Candle wick
Campfire	Air outside Wind Person blowing on fire	Lighter that started campfire	Wood put into the fire
Wood stove	Air outside Draw from chimney and stove door	Match that started fire in stove	Paper Kindling Logs

Pedagogy Note: *The emphasis of this exercise is on having the students theorize about the different ways the parts of the Fire triangle show up in day-to-day events. Discussing their responses and having them use observations and evidence to explain their reasoning is more important than whether or not the answer is 'right.'*

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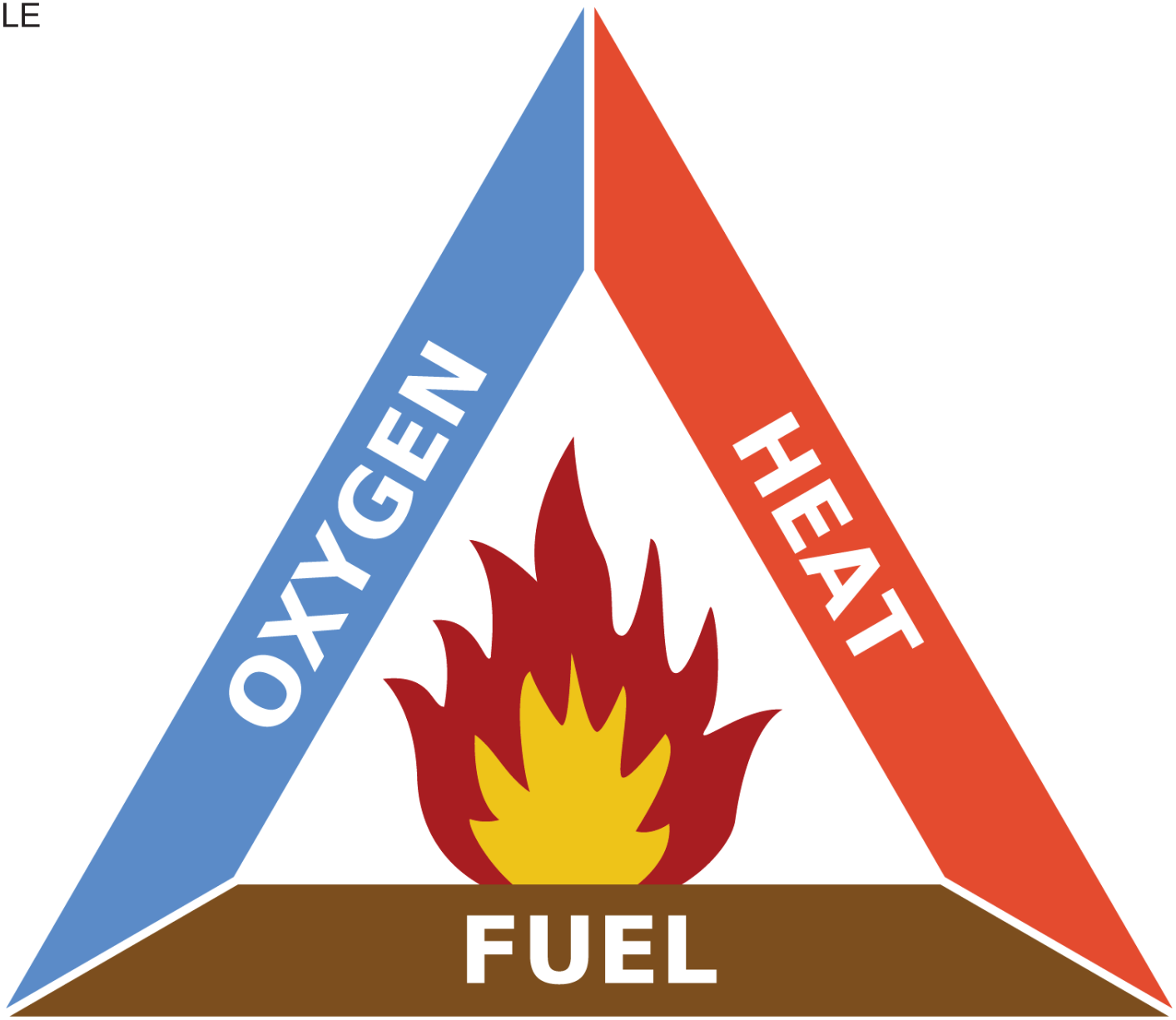
FIRE TRIANGLE



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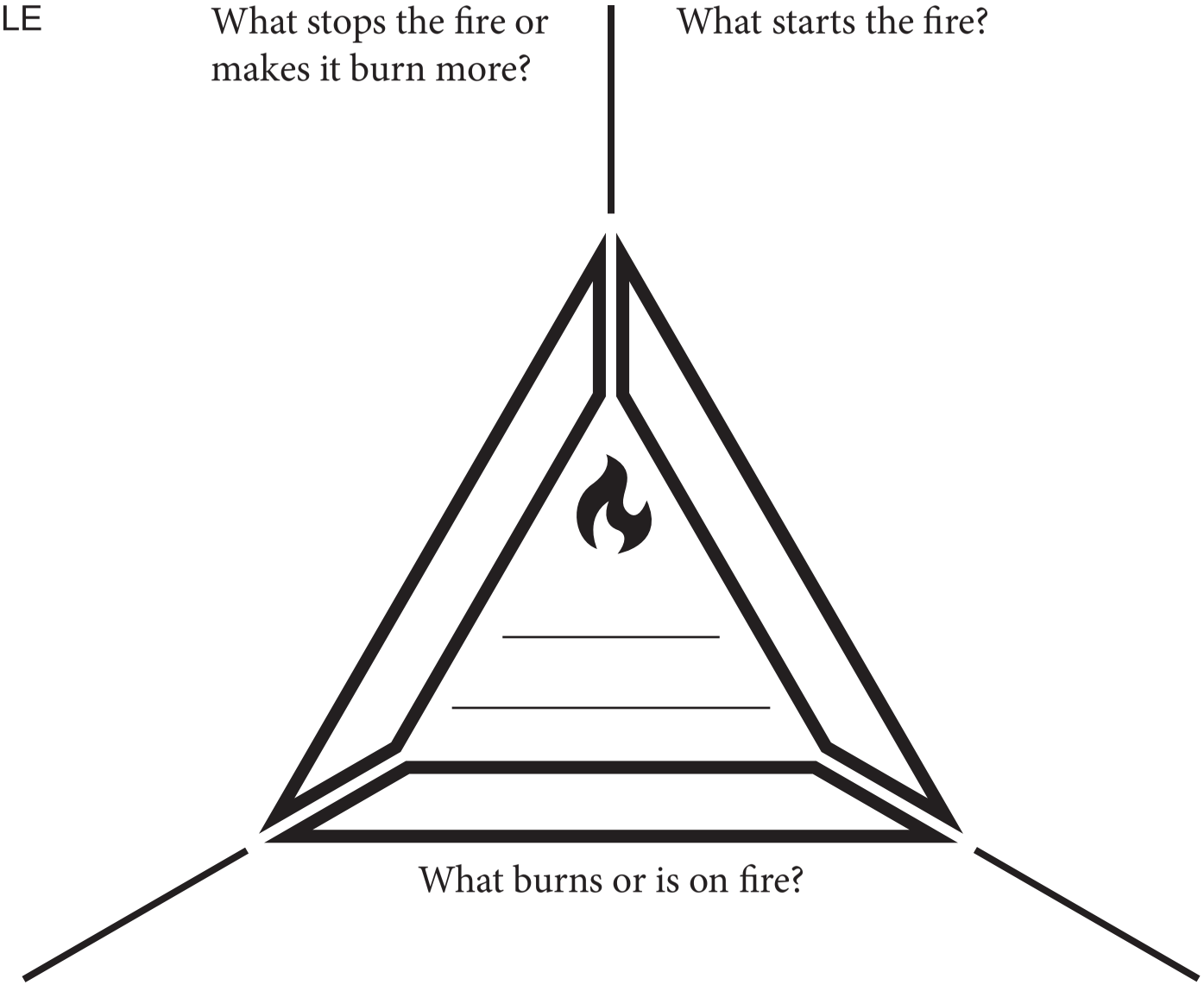
FIRE TRIANGLE TEMPLATE



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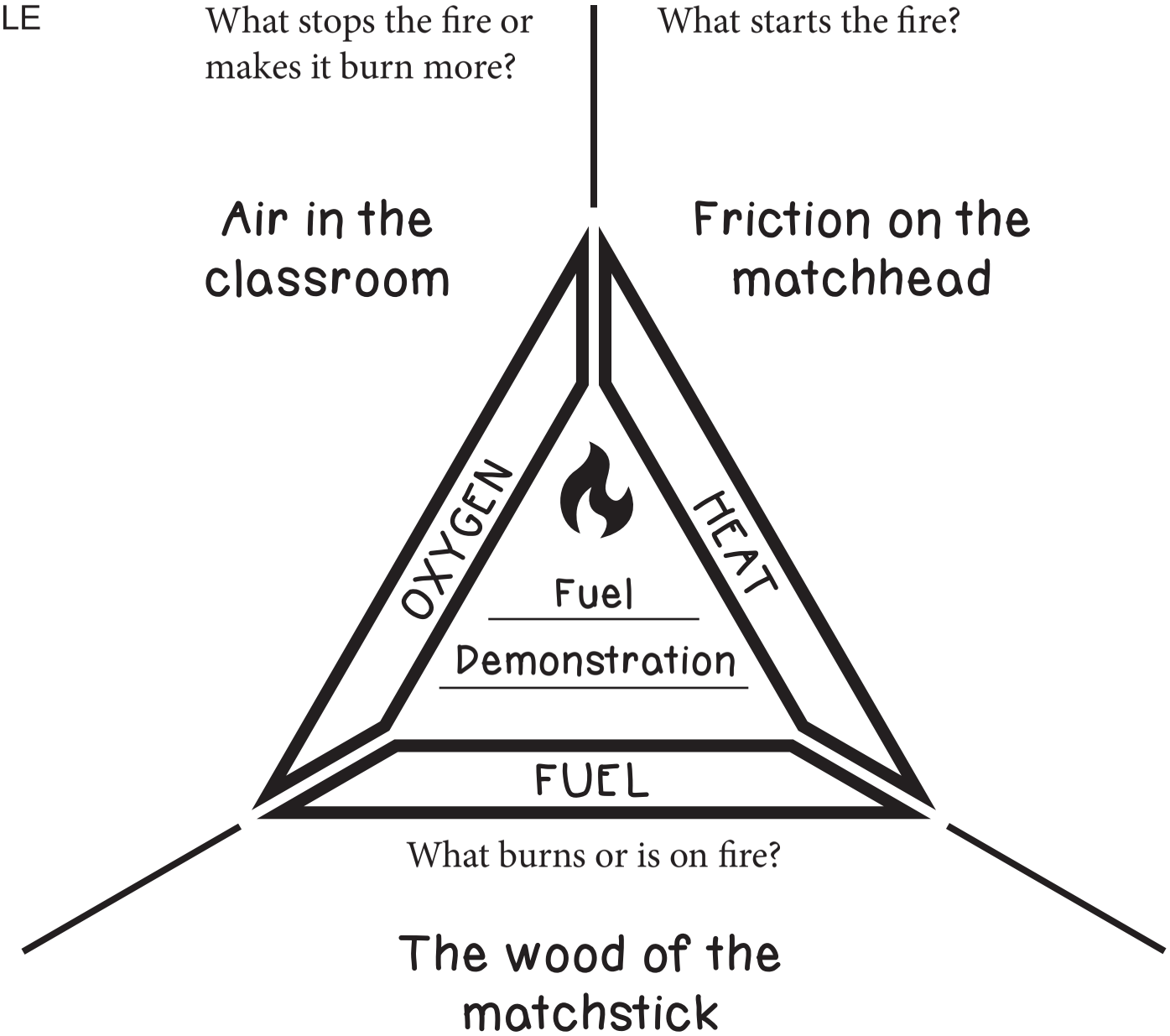
FIRE TRIANGLE EXAMPLES



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LESSON #3:
INTRODUCTION TO FIRE BEHAVIOR

GRADES:
3-5

STANDARDS:
Science Standards for Alaska and NGSS:
3-LS4-3, 3-LS4-4, 3-ESS3-1, 3-5-ETS1-2, 5-ESS2-1, 5-ESS3-1

Alaska Content and Performance Standards:
Geography: A-2, A-4, A-5, A-6, B-8, C-1, C-2, C-3, E-5, E-6, F-2, F-3

Alaska Cultural Standards:
A-4, E-2

OVERVIEW:

This and the following lessons use models to show the effects of different conditions on wildfires. Ecological systems are central to these lessons, and students learn how one part of the system can have effects on other parts of the system. Each lesson has its own variations, but they are designed to build one upon the other in numbered order.

BACKGROUND INFORMATION

Fire behavior is the term used to describe a forest fire. It includes the many different characteristics a fire can have. Many factors influence fire behavior. Weather, climate, tree density, landscape, and human structures (like roads and houses) all affect the way a fire spreads through an area. Rivers and roads can make firebreaks, and people create margins of safety around houses and other buildings. Wind fans flames, and fires burn faster uphill. In a forest, the density of trees and fuel can determine the rate at which a fire burns-- things that are closer together burn quicker.

Fire scientists have to take all of these factors into account when making decisions about managing healthy forests and handling forest fires. These lessons will help students think about the system of a forest fire with its many moving parts and changing conditions.

CONSIDERATIONS:

This work is best done in small groups of 2-4 students.

MATERIALS NEEDED

Forest Fire Scenario kit

- Forest Fire grid: fabric gameboards labeled along the edges with letter and number coordinates
- Tree / fire tokens: 100
- Blank grid sheets (templates at end of lesson)
- Pencils

ACTIVITY STEPS

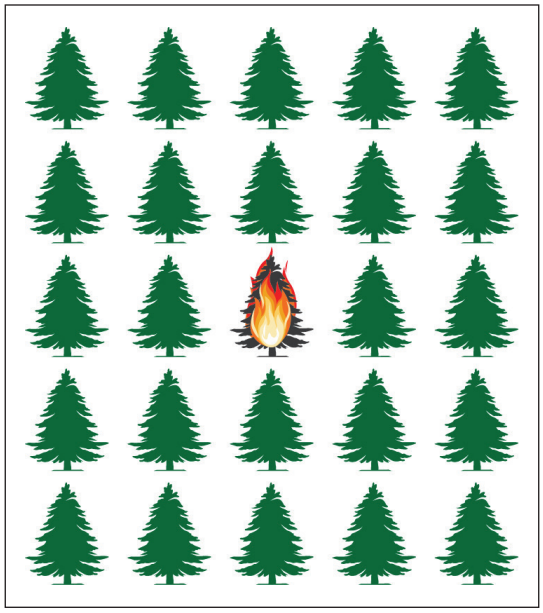
Introducing the Forest Model and Fire Simulation

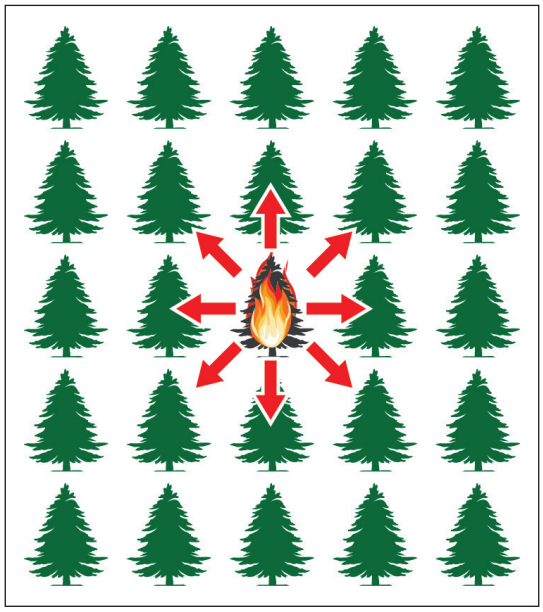
1. Have students open their gameboard grids and inspect the pieces.

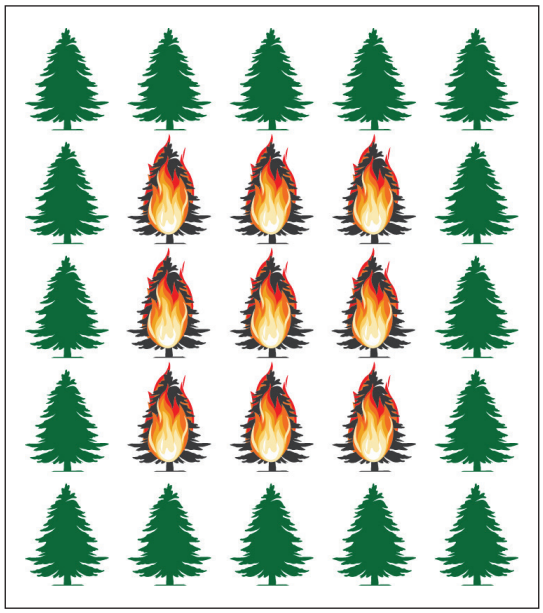
2. Describe each board as a forest. The board lines up with the cardinal directions on a compass, so that Row 1 is the southern edge and Row 10 is the northern edge. Each square is a space for a tree.

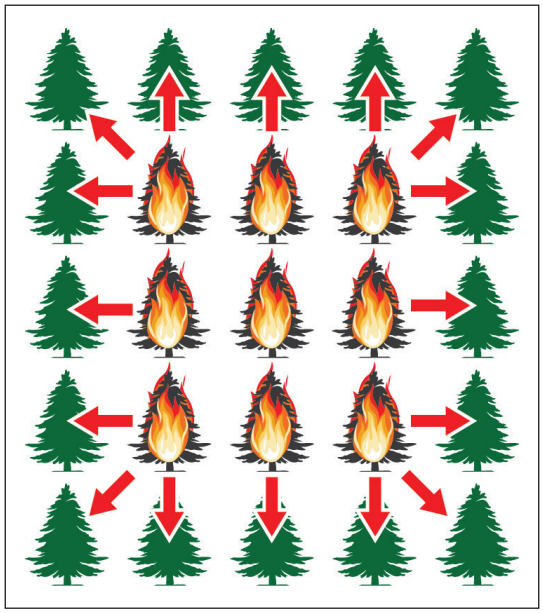
3. Trees are represented by the “tree” side of the tree/ fire tokens. Trees represent the fuel in a forest fire. When a tree catches on fire, every tree in a space next to it catches on fire, horizontally, vertically, and diagonally. Fire is indicated by flipping over a tree/ fire token to fire side, representing burning/burnt trees. The process repeats in stages.

4. Demonstrate the movement of a fire from one corner of the board to another on a 5x5 section of a board, like the illustrations below. Between stages, ask students to predict what they think will happen next. Emphasize that the trees will burn in a sequence, or "steps." This will be important later on in the curriculum.









Icons courtesy dsim-studio, freepik.com and pch.vector

5. The student groups will run through the next three exercises on their own:

   A. Fill the board with chips (1 per square). If a fire in one of the corner squares (i.e. A1, A8, H1, or H8) is Stage 1, at what stage will the entire board be on fire?

   B. Again, with a full board: If a fire in one of the center squares (i.e. D4, D5, E4, or E5) is Stage 1, at what stage will the entire board be on fire?

   C. What happens when there is a tree on every other square and a fire starts in a corner? In the center?

At this point many students may be confused about the sequencing of the fire or keeping track of which trees burn (i.e. being able to distinguish or calculate which trees burned in the first step, which trees burned in the second step, etc.) To help them, introduce the blank grid sheets (templates at end of lesson).

6. Distribute the paper blank grid sheets. Have each group select a random square on the grid, and mark it "0". Ask them "If this where the fire starts, which squares will catch fire next?" Have them label every touching square with a "1".

   Alternatively, have the students roll a 10-sided die twice to determine the coordinates where the fire starts.

7. Help the students check their work, then have them mark every blank square touching a "1" square with a 2. Continue in this sequence until the students fill their entire grids.

8. The different grids should vary, depending upon where the burn started. Have the students compare their grids. How many seps did it take to cover each grid? Which grids took the most number of steps to cover?

9. As an alternative to numbering, student may color their squares. Each step is a different color. If the entire class uses the same color sequence (i.e. 0=red, 1=orange, 2=yellow, 3=green, etc.), students can compare their patterns and make inferences about similarities and differences in the patterns.

ASSESSMENT

Students should be able to:

1. Model a forest fire as it burns

2. Track the sequence of a fire spread

3. Compare the effects of fire starting at different places on the board

4. Share theories about fire spread or behavior

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BLANK GRID SHEET

10										
9										
8										
7										
6										
5										
4										
3										
2										
1										
	A	B	C	D	E	F	G	H	I	J

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LESSON #4:
FIRE BEHAVIOR — SCENARIOS

GRADES:
3-5

TIME REQUIREMENT:
40-60 minutes or longer

STANDARDS:
Science Standards for Alaska and NGSS:
3-LS4-3, 3-LS4-4, 3-ESS3-1, 3-5-ETS1-2, 5-ESS2-1, 5-ESS3-1

Alaska Content and Performance Standards:
Geography: A-2, A-4, A-5, A-6, B-8, C-1, C-2, C-3, E-5, E-6, F-2, F-3

OVERVIEW

Small groups work through a fire scenario and show the class the specifics of their scenario.

CONSIDERATIONS

This lesson can be broken up into sections, as it requires time for students to solve and showcase their work to the rest of the class. *Groups will be demonstrating new game rules and techniques.*

MATERIALS NEEDED

- Forest Fire grid: fabric gameboards labeled along the edges with letter and number coordinates
- Tree /fire tokens: 100
- Water / dead wood tokens
- 10-sided die
- Scenarios to create and show (included on separate page)
- Markers and index cards or blank paper (for hypothesis cards)

LEARNING OBJECTIVES

The student will:

1. Create a model of a forest fire
2. Understand that different conditions affect a fire's behavior
3. Explore the effects of clear spaces, fuel, slope angle, and terrain on fire behavior
4. Explain the effects of a new rule or tile on fire behavior to the class

ASSESSMENT

The students' presentations should reflect what they have learned, with the following features:

1. Model of a forest fire burning
2. Description of the fire behavior in their scenario
3. One or more conditions that affect a fire's behavior
4. Theories about fire spread or behavior

ACTIVITY STEPS

1. Students will be demonstrating different fire behavior scenarios. First they will follow some practice exercises, then they will receive and solve their assigned scenario, and then present it to the rest of the class.
2. Divide students into groups of 2-3 and provide each group with a set of materials. Have each group practice laying out chips as trees and then documenting the progress of the fire through successive stages.
3. Each group runs through these three beginning exercises as practice:
   A. Fill the board with tree chips (1 per square). If a fire in one of the corner squares (i.e. A1, A10, J1, or J10) is the first step, how many steps will it take for the entire board to be on fire?
   B. Again, with a full board: If a fire in one of the center squares (i.e. E5, E6, F5, or F6) is Stage 1, at what stage will the entire board be on fire?
   C. What happens when there is a tree on every other square and a fire starts in a corner? In the center?
4. The scenarios are listed at the end of the lesson. Distribute the scenario cards and ask students to spend a few minutes making predictions about how the fire might behave (these can be written down). Once they have made their predictions, they will create a presentation showing their scenario. Explain that each presentation will be used to teach the rest of the class, so the presentation should include explanations about the phenomena they are demonstrating.

5. Have the students describe the initial scenario description, and write down both their scenario and their prediction. Then to make the fire progress, the students change the tokens by step across the forest fire grid, making observations or notes each time.

6. Scenario gallery — Allow 5-10 minutes per group, if possible. Have students present their scenarios and tell the class about their starting conditions, predictions, discoveries, and further questions/wonderings. Be sure to help the students explain new game rules and techniques in their scenarios.

General instructions for each scenario (also printed on each scenario sheet):

Show the class what happens when there is a fire with the special conditions in your scenario. Your presentation should include:

- *A description of the setting. (What makes it different from the way the board was set up in the practice exercises?)*
- *Your team's prediction about how the fire will burn. (Will it go faster or slower? Will it spread in every direction equally?)*
- *What you learned about the fire spread in your scenario (Did it match your prediction? Do you have any new questions or predictions now?)*

EXTENSIONS

Additional practice: Use the dry wood and wetland templates at the end of the lesson to give the students practice applying the rules of fire behavior in forests with water and dry wood.

Literature variation: Have the students write a story featuring a forest fire, creating their own scenarios with varying conditions or combining multiple conditions, and comparing the effects. They then film the scenario as a story, providing a voice-over narration.

Art variations:

1. Students draw their own forest grids and make the trees / fire / house / markers. Grids could have various landscape features and roads.

2. Students design a stop-motion animation film to show different fire behavior scenarios.

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SCENARIO 1

WATER / FIRE BREAK—RIVER

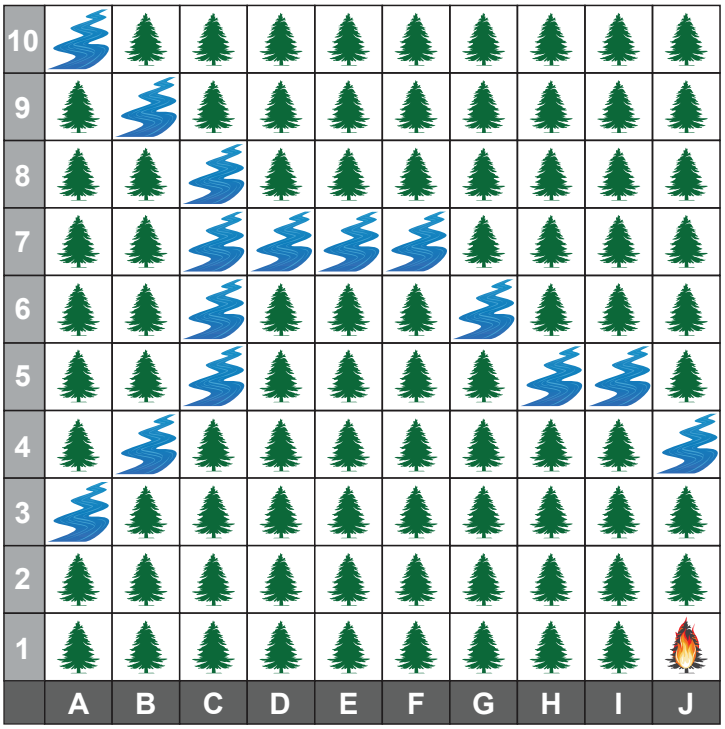
Show what happens when there is a fire with the special conditions in your scenario. Your scenario presentation should include:

1. A description of the setting. (What makes it different from the way the board was set up in the practice exercises?)

2. Your team's theory about how the fire will burn. (Will it go faster or slower? Will it spread in every direction equally?)

3. What you learned about the fire spread in your scenario. (Did it match your prediction? Do you have any new questions or predictions now?)

Mark out squares on the board to indicate the presence of a river with a fork, Just like the image below. Put trees on all the other spaces. Have the fire start in a corner on the bottom row and observe the progress as the fire burns. Remember that only squares with trees can burn.



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SCENARIO 2

SAFE MARGINS / FIRE BREAKS

Show what happens when there is a fire with the special conditions in your scenario. Your scenario presentation should include:

1. A description of the setting. (What makes it different from the way the board was set up in the practice exercises?)

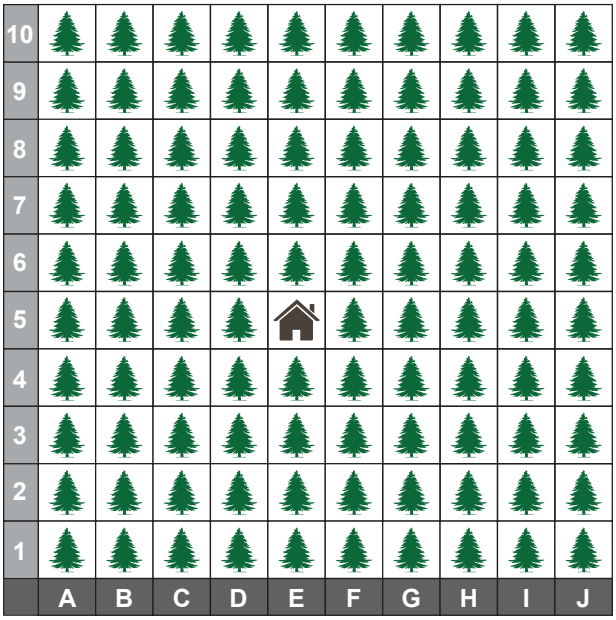
2. Your team's theory about how the fire will burn. (Will it go faster or slower? Will it spread in every direction equally?)

3. What you learned about the fire spread in your scenario. (Did it match your prediction? Do you have any new questions or predictions now?)

Fill the board with trees. Replace the tree in the middle of the board with a house. In the next two exercises, you are allowed to remove up to 10 trees, but no more.

A. How many trees do you need to remove around the house to keep it safe from fire? Start a fire at one edge of the board and demonstrate.

B. If you knew that fires started only in the bottom two rows, are there other ways to protect the house?



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SCENARIO 3

LAND—HILLSIDE

Show what happens when there is a fire with the special conditions in your scenario. Your scenario presentation should include:

1. A description of the setting. (What makes it different from the way the board was set up in the practice exercises?)

2. Your team's theory about how the fire will burn. (Will it go faster or slower? Will it spread in every direction equally?)

3. What you learned about the fire spread in your scenario. (Did it match your prediction? Do you have any new questions or predictions now?)

Fill the board with trees. Designate rows 5-10 as uphill. When fires burn they tend to travel uphill rapidly. On level ground a fire might move equally in all directions, but it will move rapidly uphill. As shown in the pattern below, when a square on the uphill side of the board (rows 5-10) catches fire, it burns uphill more rapidly. Have the fire start at a square on the bottom row and document the progress. What happens when the fire hits the hill?

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SCENARIO 4

WATER—WETLAND

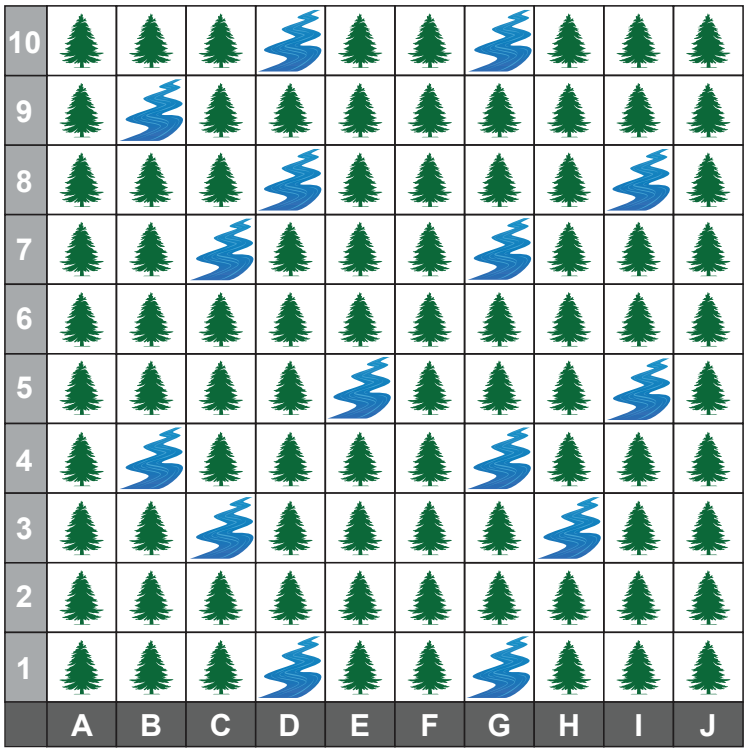
Show what happens when there is a fire with the special conditions in your scenario. Your scenario presentation should include:

1. A description of the setting. (What makes it different from the way the board was set up in the practice exercises?)

2. Your team's theory about how the fire will burn. (Will it go faster or slower? Will it spread in every direction equally?)

3. What you learned about the fire spread in your scenario. (Did it match your prediction? Do you have any new questions or predictions now?)

Squares with water on them don't burn. Put water squares on the board just like the illustration below. Put trees on all the other spaces. Pick a spot on the board to start the fire and document the progress. Remember that only squares with trees can burn.



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SCENARIO 5

DRY WOOD

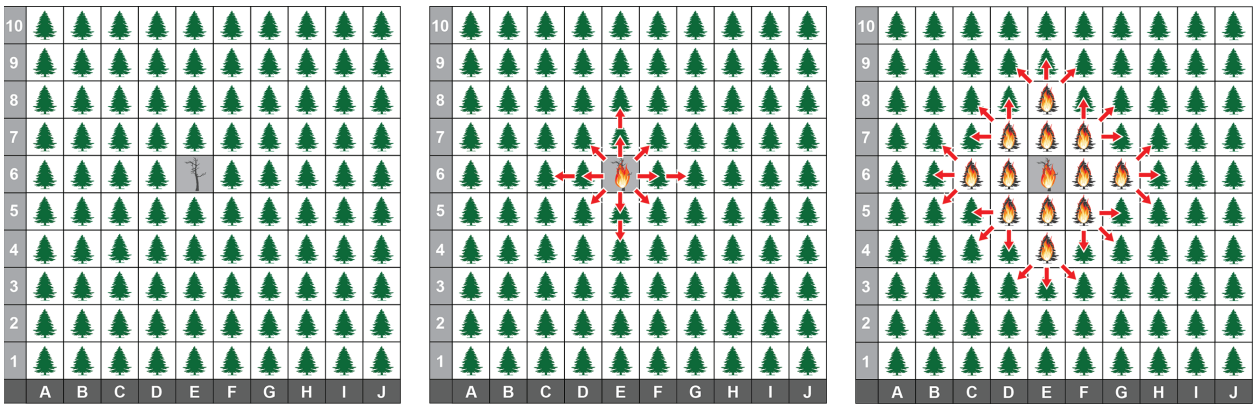
Show what happens when there is a fire with the special conditions in your scenario. Your scenario presentation should include:

1. A description of the setting. (What makes it different from the way the board was set up in the practice exercises?)

2. Your team's theory about how the fire will burn. (Will it go faster or slower? Will it spread in every direction equally?)

3. What you learned about the fire spread in your scenario. (Did it match your prediction? Do you have any new questions or predictions now?)

The gray squares have lots of dead wood in them, making the area very flammable. A fire in these areas spreads farther in the four cardinal directions (North, East, South, West) surrounding it. It still only burns one square in the diagonal directions. Once the fire spreads to the green trees, they burn the same way, one square in every direction. Fill the board with trees. Replace three green tree squares with gray dead wood squares and show how the fire burns.



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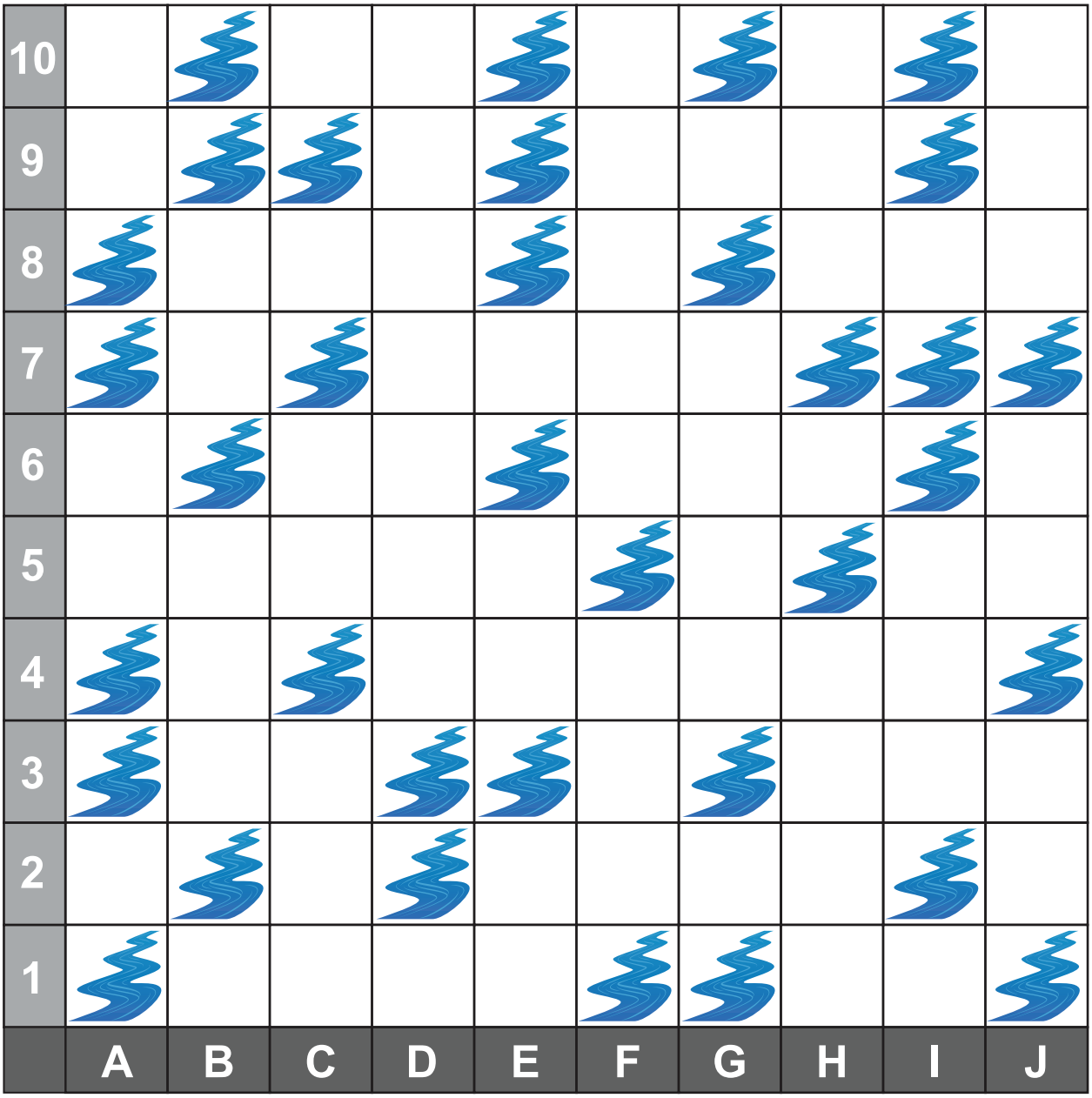
WETLAND

NORTH ↑



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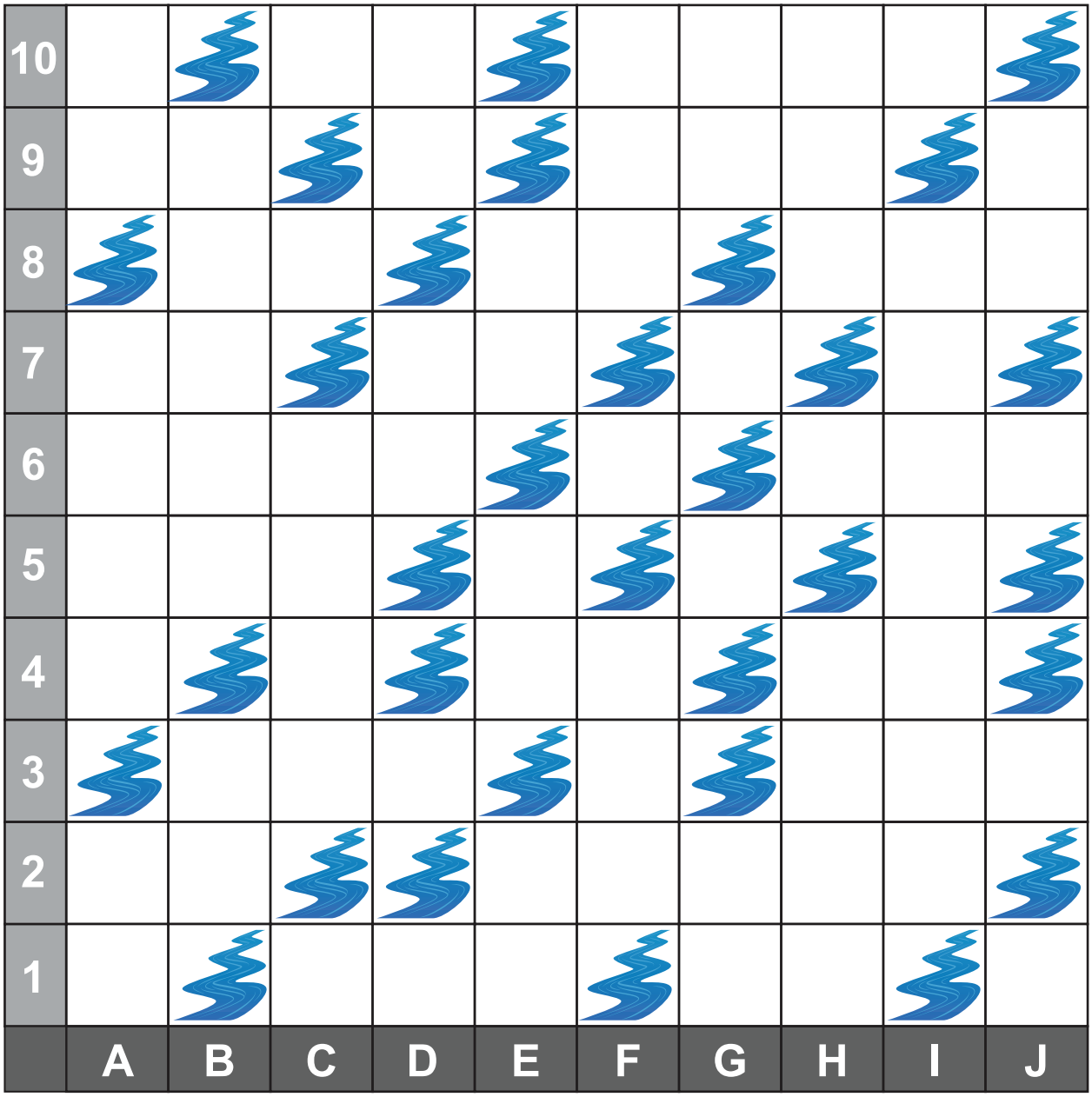
WETLAND 2

NORTH ↑



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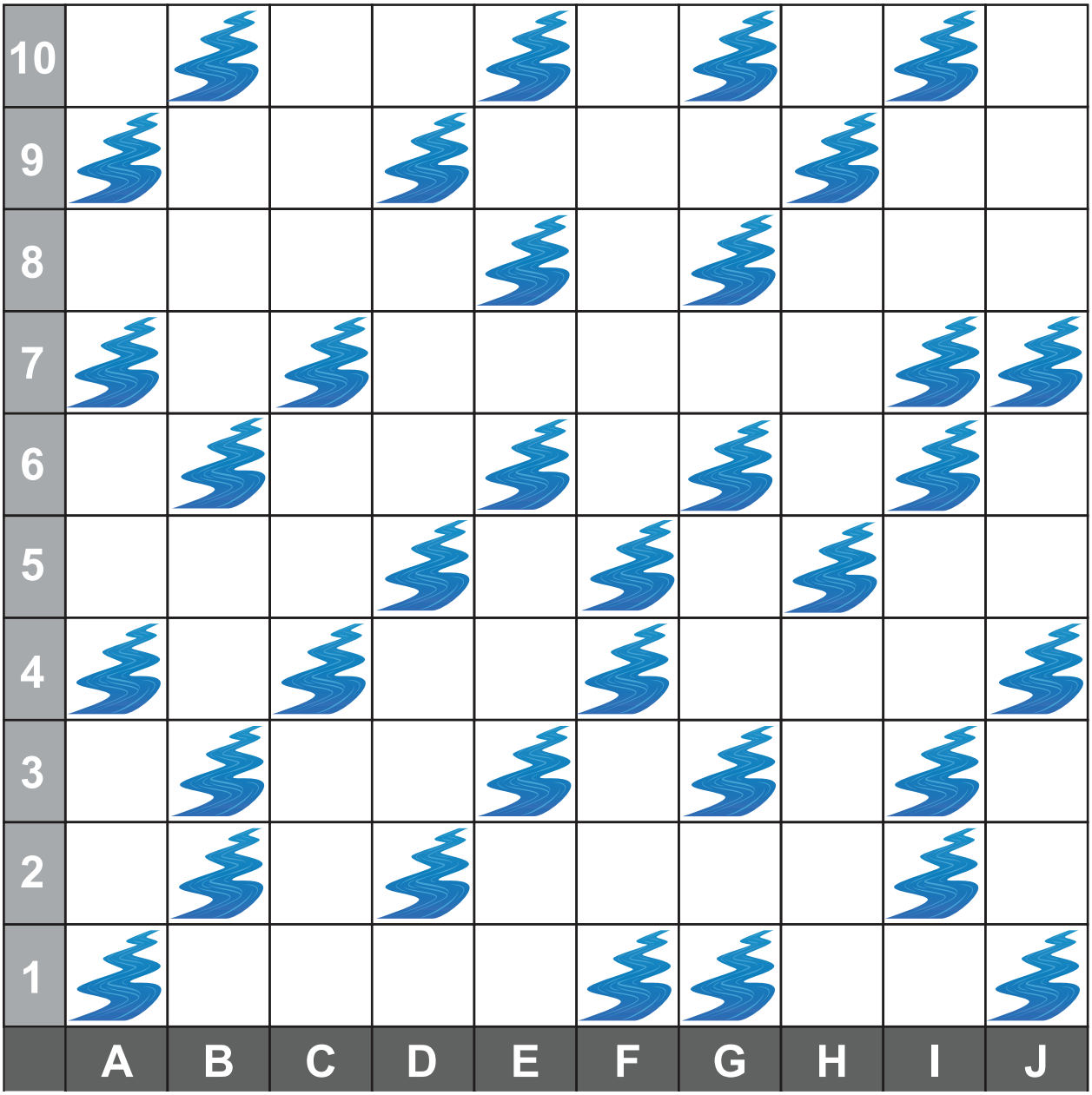
WETLAND 3

NORTH ↑



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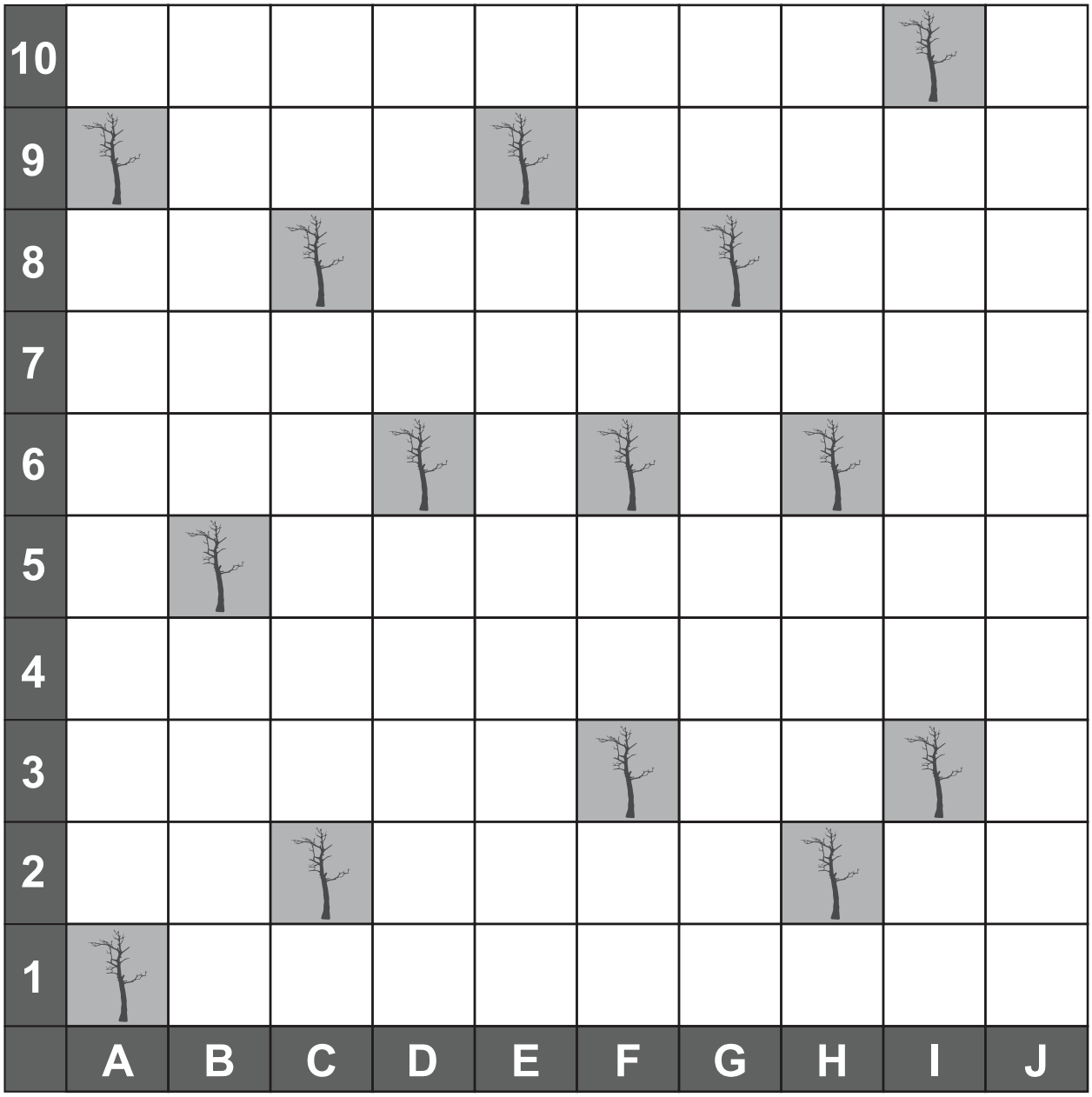
DRY TREES

NORTH ↑



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DRY TREES 2

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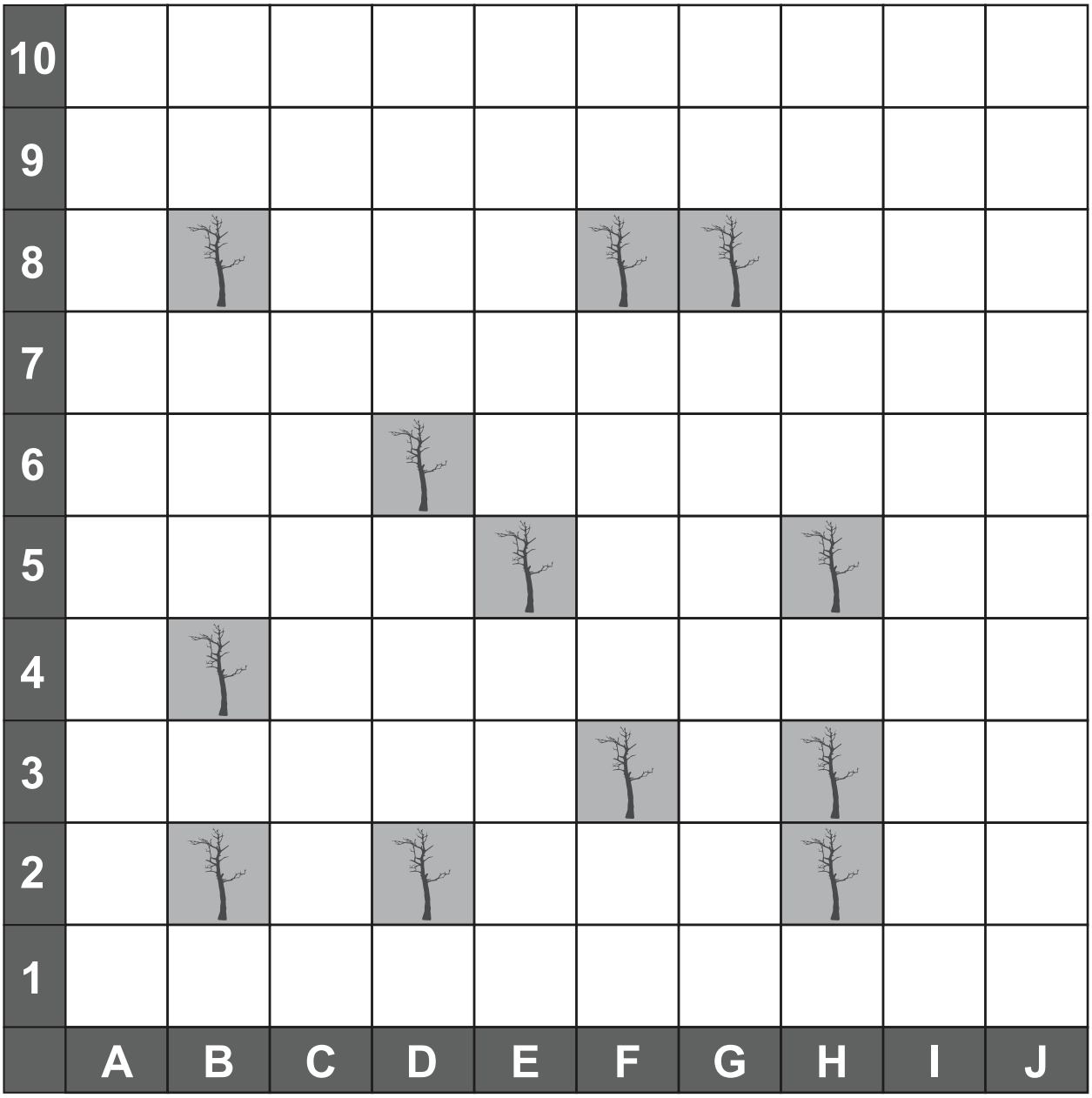

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DRY TREES 3

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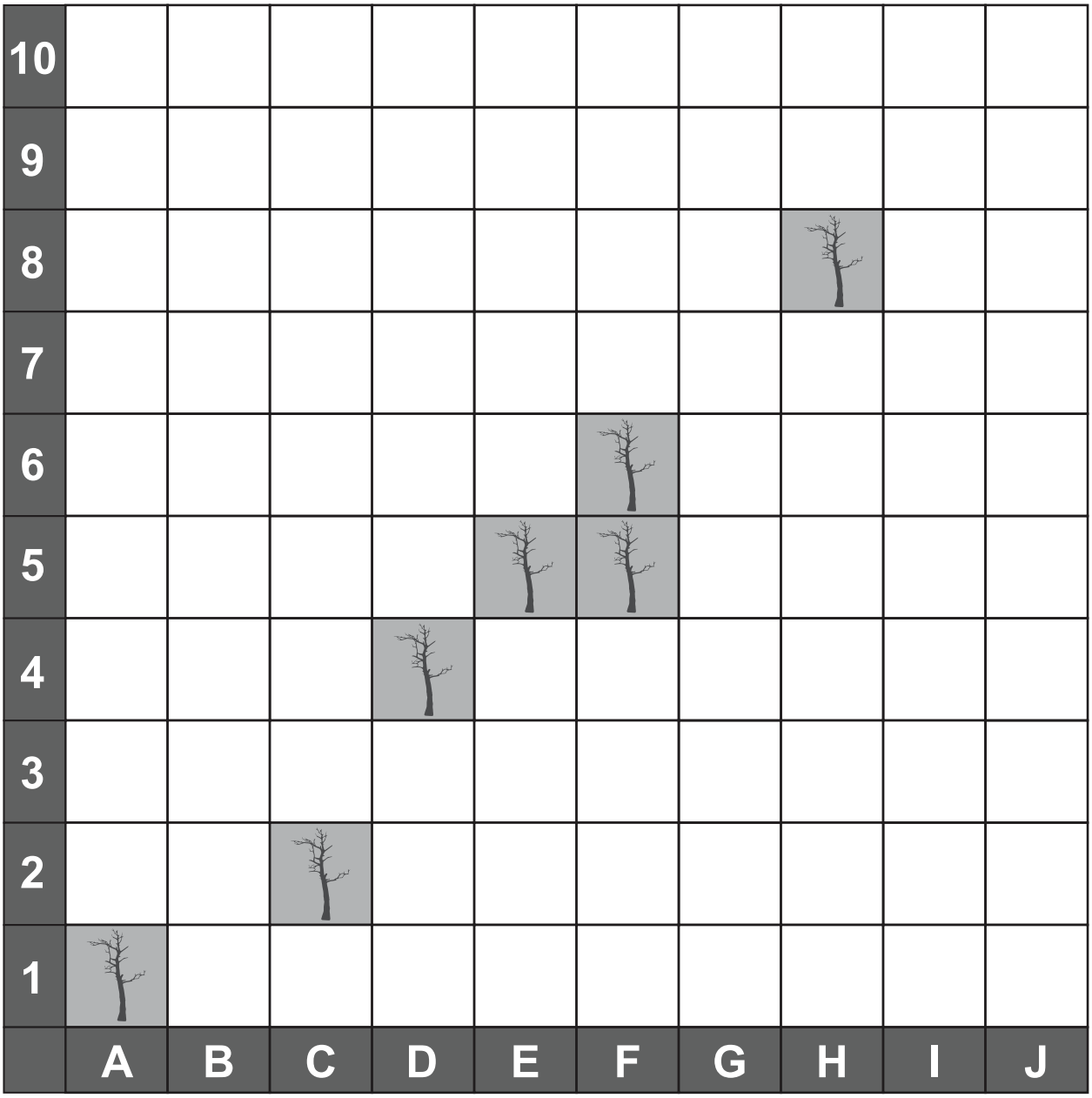

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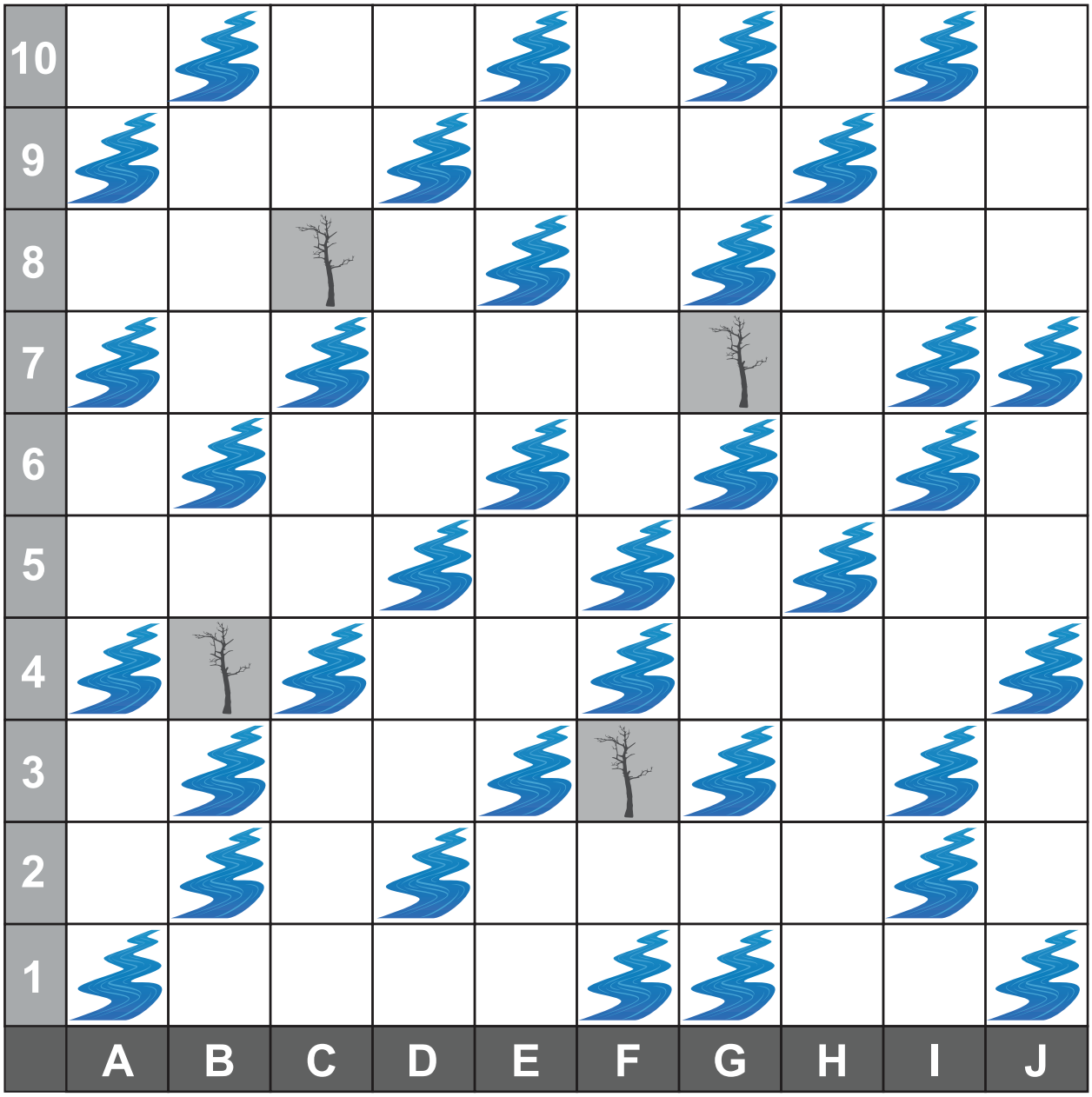
WETLAND WITH DRY TREES

NORTH ↑



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LESSON #5:
FIRE BEHAVIOR — FIREFIGHTERS, FUEL LOADS, PRESCRIBED BURNS

GRADES:
3-5

TIME REQUIREMENT:
40-60 minutes or longer

STANDARDS:
Science Standards for Alaska and NGSS:
3-LS4-3, 3-LS4-4, 3-ESS3-1, 3-5-ETS1-2, 5-ESS2-1, 5-ESS3-1

Alaska Content and Performance Standards:
Geography: A-2, A-4, A-5, A-6, B-8, C-1, C-2, C-3, E-5, E-6, F-2, F-3

Alaska Cultural Standards:
A-4, E-2

OVERVIEW:

Small groups work to control fire for specific habitats and conditions.

MATERIALS NEEDED

- Forest fire grid: fabric gameboard with number and letter columns
- Tree/fire tokens
- Water/dead wood tiles
- Firefighter tokens
- Yellow "protected" discs

LEARNING OBJECTIVES

The student will:

1. Model prescribed burns and controlled forest fires
2. Play the role of wildlife managers by practicing decision-making skills and designing solutions for managing wildfire and habitat
3. Demonstrate understanding of the role of rivers and manmade fire breaks in wildfire management
4. Explain that different animals thrive in different habitats and that wildfire creates new habitat for some creatures

ASSESSMENT

Students can:

1. Model a prescribed burn and controlled forest fires by accurately advancing the model fire in all five scenarios A-E.

2. Use decision-making skills relevant to managing wildfire and habitat by placing model fire fighters and fire breaks in four scenarios B-E.

3. Identify the two points that fire can jump the river in scenario A and developing feasible solutions in scenarios C and E.

4. Identify animals that thrive better in a post fire habitat than in a mature forest and describe how a forest fire can improve/ increase habitat for those creatures.

ACTIVITY STEPS

1. Open a discussion with the students about the importance of different kinds of landscapes for different plants and animals. Introduce the idea of wildlife management

   "We're taking a look at how fire can help make different types of habitats for animals. You are going to be the wildlife managers for a section of land. You want to be sure that there is good habitat for all kinds of animals. Right now the land is covered by a thick forest of trees. As a wildlife manager, you will use fire to help make different kinds of habitat.

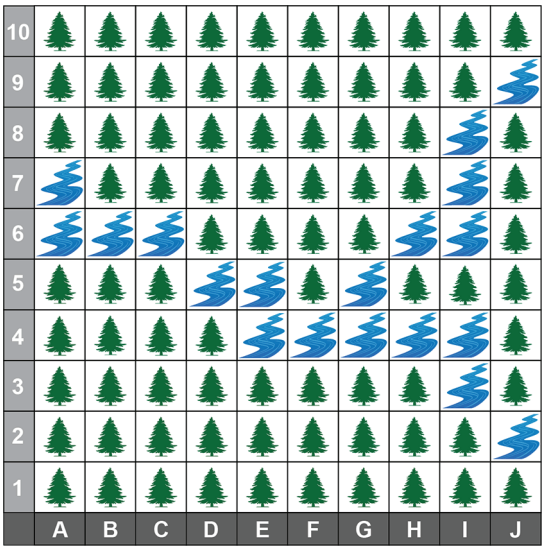
   What are some animals in Alaska that need different habitats? What are some of those habitats? *Solicit different student ideas.*

2. Have the students set up their own boards and prepare to follow through the five scenarios below.

A. Prescribed Burn

"You have been asked to set up a prescribed burn on a small section of the forest. A prescribed burn is a fire that is intentionally set and then carefully watched. Prescribed burns allow wildlife managers to create habitat for different kinds of animals. What happens if you start a fire in H1?

Students should set up their boards following the patterns below. There is a large version of the template in the material at the end of this lesson. Help the students realize that the fire will jump the river at I2 to J3 (step 3); H5 to F6 and C5 to D6 (step 7); and J8 to I9 (step 9).

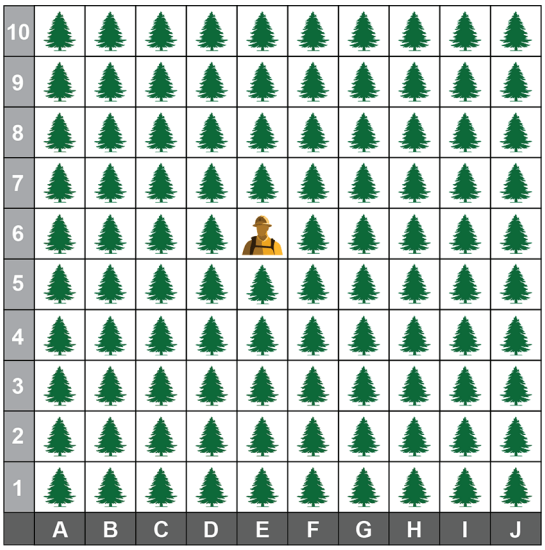


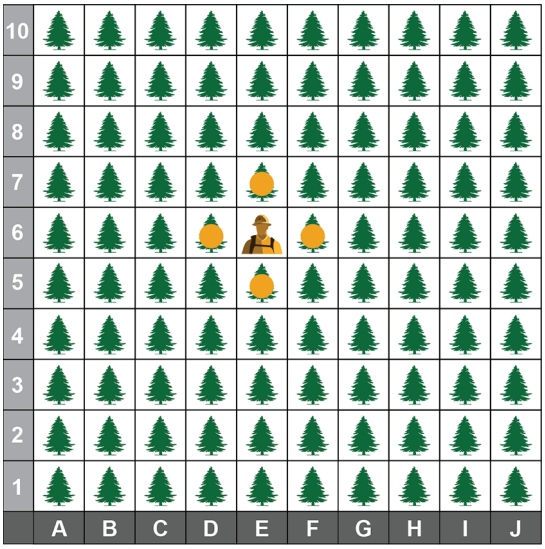
B. Firefighters

"You realize that you need firefighters to help you manage the burn. When you put a firefighter on a square with a tree, that square will not burn. A firefighter can also protect up to four other squares, but those squares must touch the square they are standing on, either directly or diagonally. Place a yellow chip on top of a square to show that it is protected. If there is a wood, tree, house or water marker in the square, put the chip on top of or under the token.

How many firefighters will you need to safely burn all the area South of the river? Where do you put them?

Solicit student answers; two firefighters at J3 and D6 will stop the burn. If the students put firefighters below (South of) the river, not all the trees in that section will burn.





C. Fire Break

"Your test burn is successful and new growth is coming into the area. Moose are eating the new shoots and birds are eating the bugs that come to pollinate the flowers of the new growth. You are asked to manage a new piece of land, one that does not have a river. However, you do have access to a bulldozer that can plow a strip of land down to rocks and soil. This is a type of fire break. You have been asked to conduct a prescribed burn that is big enough to cover 10 squares, but ONLY 10 squares. Where will you cut the fire break?

Facilitate student discussion about possible options. One option is to block out row 2, 9, or column B, or I.

D. Lots of Dead Wood

"As a forest matures the trees grow taller and shade the space beneath them. Fewer young plants and flowers can get enough light and nutrients to grow. How do you think this would affect the animals we talked about earlier?

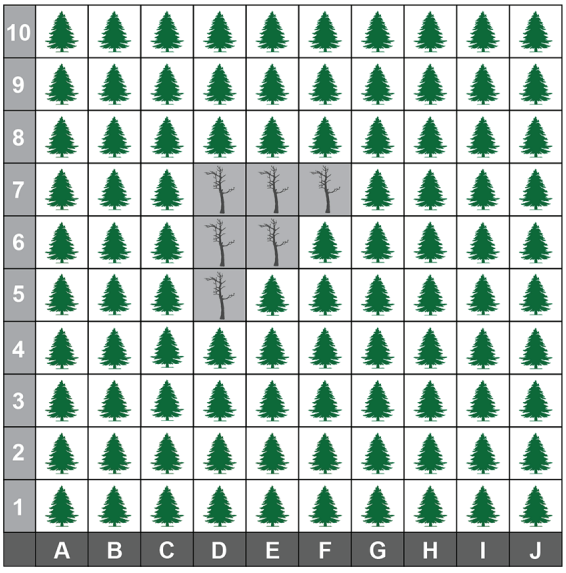
Guide the students in reasoning that the mature forest would no longer be good habitat for those creatures so they would be likely to move to better habitat.

"Place dead wood tokens a on squares D5, D6, D7, E6, E7, and F7. Place trees on all the remaining squares. This is a different part of the forest, one which hasn't been allowed to burn for a long time. As a result, there is a lot of dead wood on the ground, which acts as extra fuel for a fire, making the area very flammable.

A fire in these areas spreads farther in the four directions surrounding it. The gray squares have lots of dead wood in them--they have too much fuel. When a fire burns in a forest with this much dead material, firefighters have to be extra careful.

"You are asked to burn this space with too much fuel, but only the squares with dead wood. How many firefighters do you need to keep it safe? Where will you put them?"

Facilitate student discussion about possible options. It will probably require at least four firefighters.



E. Wind and Weather

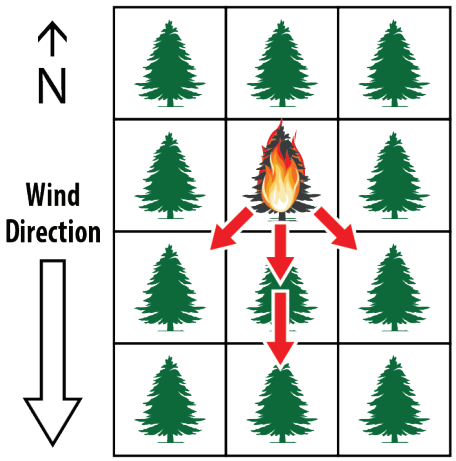
"Fire fighters often have to think about the weather where they are going to fight a fire. What are some types of weather than

affect forest fires? What is the difference between a rainy *day* and a rainy *climate*? What kids of climates are more likely to have fires?"

"One condition that can be especially important in forest fires is wind. Going back to the fire triangle in Lesson 2, how might wind affect fires? We're going to experiment with wind on our forest boards. Fill your boards with trees."

"The burning rule for wind is two squares in the direction that the wind is *coming from,* one square to each side, and no squares against the wind burn. For example, if there is a strong wind coming in from the North (the top of the board), and a tree is burning, two squares to the South, one quare each to the Southeast and Southwest catch fire, and no squares to the North catch fire."

Have the students start fires at the top row of the board (be sure to have at least one group start from each corner) and compare the effects and progress of the fire as it starts from difference positions.



Afterwards, have the students discuss their theories about wind and fire.

CLOSING DISCUSSION

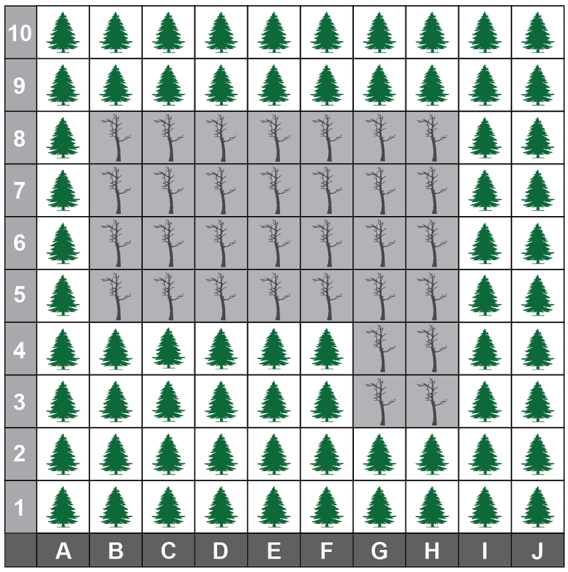
Forest fires are one way to manage wildlife habitat. What are some potential positive or negative consequences of using fire?

EXTENSION

Larger Areas

"Cover squares B8-H8, B7-H7, B6-H6, B5-H5, G4, H4, G3, and H3 with square dead wood tokens (see illustration below). Place trees on all the remaining squares. This is a section of forest with a large amount of dead wood. In the forest below, a tree has caught fire at C2. We want to keep the fire from spreading to the part of the forest that has lots of dead trees and fuel.

How would you do this with firefighters? How would you do it with a bulldozer (making a fire break)?



icons courtesy dcim-studio, freepik.com, pch.vector, pngwave, and GI Design Services, UAF

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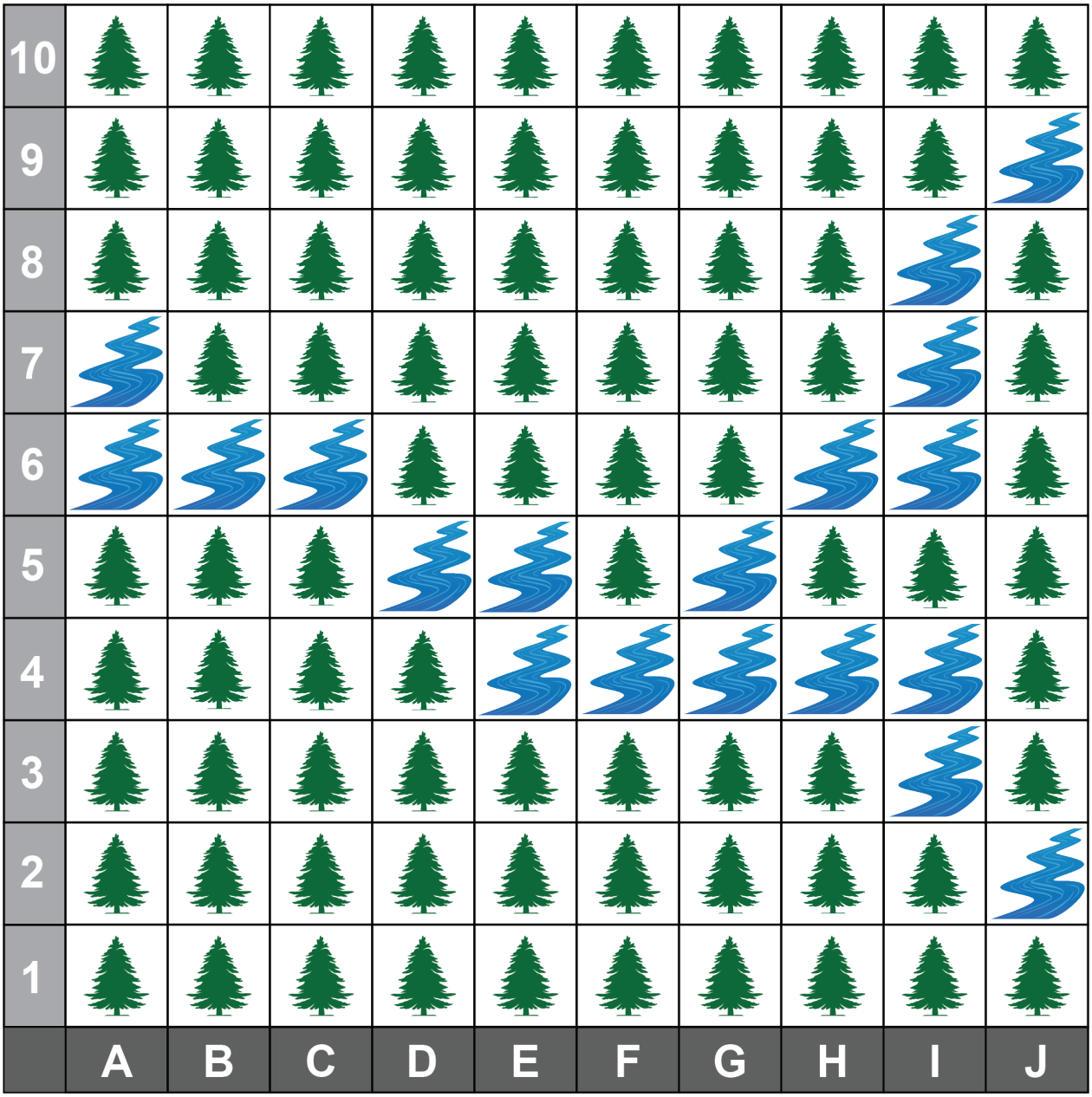
TEMPLATE FOR PRESCRIBED BURN SCENARIOS



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LESSON #6:
FIRE BEHAVIOR – WEATHER AND CHANCE

GRADES:
3-5

TIME REQUIREMENT:
40-60 minutes or longer

STANDARDS:
Science Standards for Alaska and NGSS:
3-5-ETS1-3 4-ESS3-2, 5-ESS2-1
Alaska Content and Performance Standards:
Geography: A-2, A-4, B-8, C-1, E-5, E-6
Alas ka Cultural Standards: E-1, E-2

OVERVIEW:

Small groups make a forest model and experiment with different conditions, observing what happens when things such as climate and weather change.

MATERIALS NEEDED

- Forest fire game kit for each student group
- "Game Guide and Rules" for each student group (copy at end of lesson)
- "Fire Behavior Record" for each student group (copy at end of lesson)

LEARNING OBJECTIVES

The student will:

- Model forest fires and make observations about fire behavior
- Experiment with variations in wind, terrain, and rain on fire volatility
- Understand that lightning strikes start fire
- Record data on a sheet in order to compare different conditions

ASSESSMENT

Students are able to:

- Describe the movement of a fire through a forest
- Name factors that affect wildfires and explain their effects
- Interpret and record weather data
- Make predictions about fire behavior under different conditions

ACTIVITY STEPS

1. This lesson should only be done after the students have had an opportunity to experiment with the forest fire game and all of the different pieces. Review the previous lessons or have the students refresh their memories using the templates at the end of Lesson 4.

2. Students will create a board and then experiment with different conditions, observing what happens when things such as climate, wind, and topography vary. Students should write down the conditions they roll and record their observations on the "Fire Behavior Record" sheet each time they play through a scenario.

3. Once the students are ready, give them the "Fire Behavior Record" sheets and the "Game Guide and Rules" *(separate pages)*.

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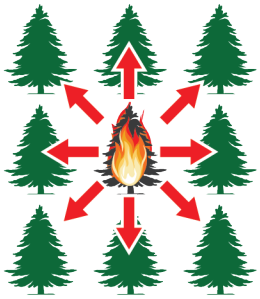
GAME GUIDE AND RULES (1 OF 2)

TREE

One part of a forest.

FIRE

Burns trees and other fuel. Normally burns in all eight directions around it.



DIRECTIONS

Fire normally burns in all eight directions around it.

HOUSE

Burns like a tree. You might want to protect it.

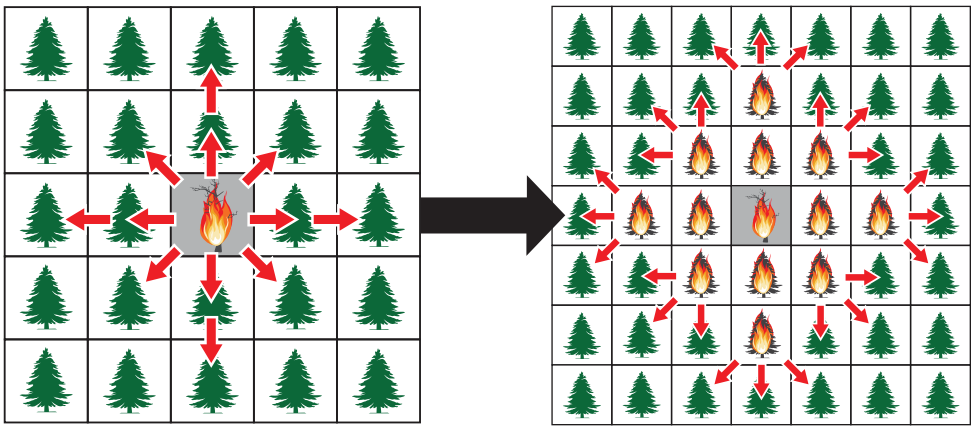
WATER

Squares with water will not burn.

DEAD WOOD

These squares are very volatile. They burn two squares on each flat side and one diagonally.

DEAD WOOD EXAMPLE



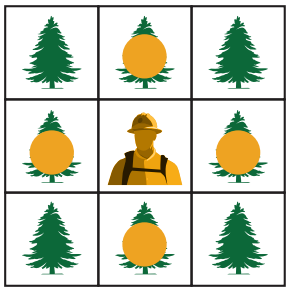
The dead wood is extra fuel and burns more trees around it.

The trees on fire now burn like regular trees.

GAME GUIDE AND RULES (2 OF 2)

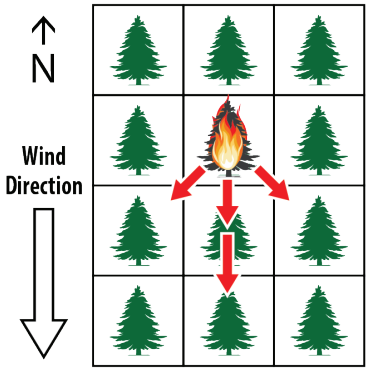
FIREFIGHTER

Keeps the square that they are on from burning. They can also protect up to four other squares that are touching the square that they are on.



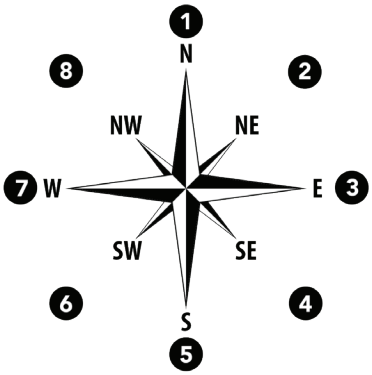
PROTECTION

In this case, the firefighter is protecting the four squares directly to each side of the square that they are standing on.



WIND

Burns two squares in the direction the wind is blowing from, one square in the two directions next to it on either side. The side and back squares do not burn. In this case, the wind is blowing from the North.

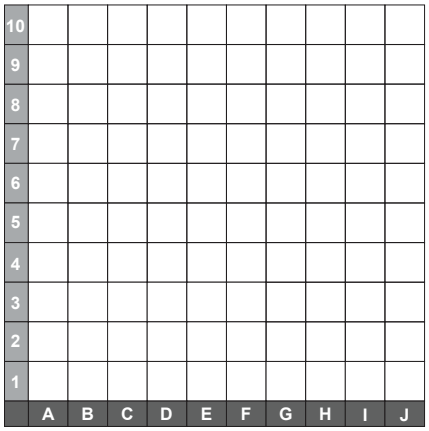


DIRECTION

We roll the 8-sided die to determine the direction the wind is blowing from.

EXAMPLE:

Maria rolled a 7. She used the compass to figure out that the wind is blowing to the West. She put the arrow next to her board like this:



FIRE BEHAVIOR RECORD (1 OF 5)

Board Conditions — these stay the same for all three rounds

Set up the board so it has:

- 1 house with a fire break
- At least 65 trees
- 10-15 water squares
- 7-10 squares with dead wood

Write down the number of trees, river squares, and houses that you choose to put on your board below:

Trees: _____ **Water:** _____ **Dead wood:** _____

FIRST ROUND

1. **Roll an 8-sided die for climate**

Roll	Climate	Conditions
1 or 2	Very wet	Trees only burn in four directions, North, South, East, West
3 or 4	Wet	Trees burn in all 8 directions
5 or 6	Dry	Trees burn in all 8 directions, plus for two spaces in the direction of wind, but the fire cannot jump breaks
7 or 8	Very Dry	Trees burn for 2 spaces and the fire can jump a fire break (1 space)

Write down the number you rolled and the climate conditions.

Number: _____ **Condition:** _____

* If you get a Very Wet Climate, look for a special rule later on.

2. **Roll a die for wind/no wind**

Even numbers are wind, odd number are no wind.

Write down the number you rolled and whether there is wind.

Number: _____ **Is there wind?** _____

* If you have wind, roll the 8-sided die for wind direction. Look at the compass to figure out which direction the wind is rolling from. If there is no wind, skip to lightning.

Write down the number you rolled and the wind direction.

Number: _____ **Wind direction:** _____

FIRE BEHAVIOR RECORD (2 OF 5)

3. **Roll for a lightning strike**
   Roll a 10-sided die twice to see where lightning hits and start the fire. The first roll is the row across, same as the number you rolled. The second roll is the vertical column: 1=A, 2=B, 3=C, 4=D, 5=E, 6=F, 7=G 8=H, 9=I, 10=J.

   Write down the numbers you rolled and the location of the lightning strike.

   First number: _____ Second number: _____ Strike location: _____

   SPECIAL RULE FOR VERY WET CLIMATE:

   After rolling to determine the lightning location, roll again. The trees around the lightning strike only catch fire if the roll is an even number.

   VERY WET CLIMATE ONLY: Write down the number you rolled and if the trees burn.

   Number: _____ Will the trees catch fire? _____

   Look at your board conditions, climate, wind, and lightning strike location. What do you think is going to happen? **Explain why.**

   _____

   _____

   _____

4. **Continue the fire until everything is burned or the fire cannot burn any longer.**

   What happened? Did the fire burn the way you thought it would?

   _____

   _____

   _____

FIRE BEHAVIOR RECORD (3 OF 5)

Return the board to its original conditions with the house, rivers and dead wood in the same places as before. For the second round, you will roll again for climate, wind and lightning.

SECOND ROUND

1. **Roll an 8-sided die for climate**

   Write down the number you rolled and the climate conditions.

   Number: _____ **Condition:** _____

2. **Roll a die for wind/no wind.**

   Write down the number you rolled and whether there is wind.

   Number: _____ **Is there wind?** _____

   If there is wind, roll for direction. Write down the number you rolled and the wind direction.

   Number: _____ **Wind direction:** _____

3. **Roll for a lightning strike.**

   Remember there is a special rule for a very wet climate.

   Write down the numbers you rolled and the location of the lightning strike.

   First number: _____ **Second number:** _____ **Strike location:** _____

   VERY WET CLIMATE ONLY: Write down the number you rolled and if the trees burn.

   Number: _____ **Will the trees catch fire?** _____

   Look at your board conditions, climate, wind, and lightning strike location. What do you think is going to happen? Explain why.

   _____

   _____

   _____

FIRE BEHAVIOR RECORD (4 OF 5)

4. **Continue the fire until everything is burned or the fire cannot burn any longer.**

   What happened? Did the fire burn the way you thought it would?

   _____

   _____

   _____

THIRD ROUND

1. **Roll an 8-sided die for climate**

   Write down the number you rolled and the climate conditions.

   Number: _____ **Condition:** _____

2. **Roll a die for wind/no wind.**

   Write down the number you rolled and whether there is wind.

   Number: _____ **Is there wind?** _____

   If there is wind, roll for direction. Write down the number you rolled and the wind direction.

   Number: _____ **Wind direction:** _____

3. **Roll for a lightning strike.**

   Remember there is a special rule for a very wet climate.

   Write down the numbers you rolled and the location of the lightning strike.

   First number: _____ **Second number:** _____ **Strike location:** _____

   VERY WET CLIMATE ONLY: Write down the number you rolled and if the trees burn.

   Number: _____ **Will the trees catch fire?** _____

   Look at your board conditions, climate, wind, and lightning strike location. What do you think is going to happen? Explain why.

   _____

   _____

FIRE BEHAVIOR RECORD (5 OF 5)

4. Continue the fire until everything is burned or the fire cannot burn any longer.

What happened this time? Did all the fires burn the same way?

_____

_____

_____

Now that the fires have burned three times with the same basic conditions, compare the different ways the fires burned. What had the biggest effect in how the fires burned?

_____

_____

_____

Were there things that surprised you? Why or why not?

_____

_____

_____

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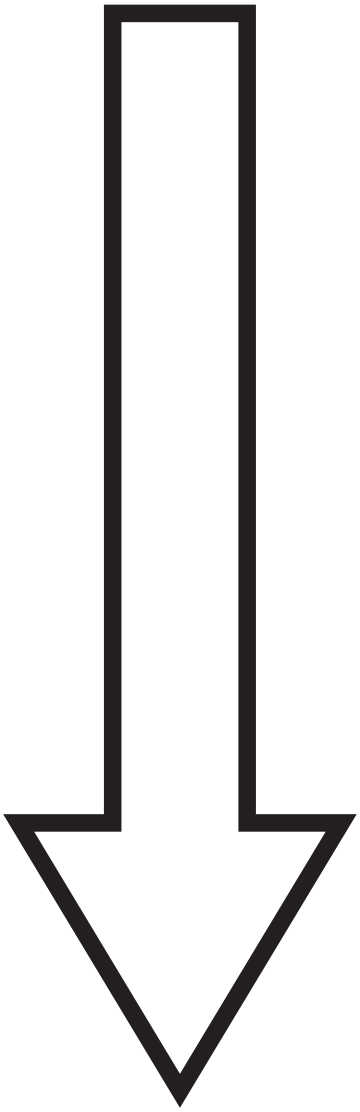
GAME PIECE INVENTORY

Bag Contents	#
board (10x10)	1
tree/burn tokens	100
water/brush tokens	35
firefighters	15
protected squares	60
houses	20
8-sided die	1
10-sided die	1
6-sided die	1
big mesh bag	1
tree/burn tokens	100
houses	20
water/brush tokens	35
protected squares	60
firefighters	15
8-sided die	1
10-sided die	1
6-sided die	1

WIND DIRECTION

Use this arrow to show wind direction after you roll the dice (Lesson #5)



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