Section 6: Fire on the Range

1. **Fire Triangle, Fire Behavior, and Fuel Management**
2. **What Burns Best?**
3. **Skills Challenge: Matchstick Rangeland**

Learning Objectives:

- Describe each component of the fire triangle
- Describe the components of the fire behavior triangle
- Determine which types of fuels burn best
- Explain fuel management techniques, including the "Green and Brown" guide
- Identify and compare the effects of slope, woody species arrangement, and understory growth on fire behavior.

Idaho General Education Performance Standards

- ESS2-5-1, PSI-5-3, PSI-MS-2, ESS3-5-1, ESS3-MS-2, ESS3-MS-3, PS3-MS-2, PS3-MS-3, LS2-MS-6

Introduction: The Role of Fire on Rangelands

Fire is an important and natural part of rangelands. Many plant and animal species have adapted to fire and can benefit from it. Fires can clean out diseased or dead forage and trees. However, just like floods and other natural disasters, fire can produce dramatic change in a short period of time.

Beneficial fires in Idaho are relatively small and create a mosaic of age classes of plants (e.g., small areas of shrubs would burn and perennial grasses would grow for several years in the burned areas until shrubs became reestablished). These types of fire create openings that allow seeds to sprout in sunlight creating areas with high plant diversity, which ultimately creates habitat for a diverse mix of mammals, birds, fish, reptiles, and amphibians.

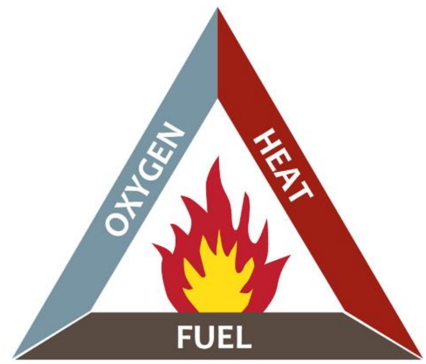
Wildfires over the last few decades, however, have shifted from being small to large. According to the National Interagency Fire Center (NIFC), across the nation the number of fires since 1960 has decreased by 46%, yet, the total acres burned has increased 28% or approximately 1.3 million acres. That means, there are less fires, but when it does burn, it burns a lot!

1. Fire Triangle, Fire Behavior Triangle, and Fuel Management

Time: 15-20 minutes
Supplies: Fire triangle (2 per student), "Green and Brown" chart

Do:
Ask students to describe what is fire? How does it burn?

- Explain that fire is a result of a chemical reaction that requires the presence of heat, fuel, and oxygen. Have students fill in the fire triangle with the 3 components and discuss each one:
    - **Fuel**: is any material that will burn. Ask team members what will burn on rangelands?
    - **Heat**: is provided by the ignition source (fire's ignition decomposes compounds, releasing the flammable gases that react with oxygen to burn). Ask team members how fire starts? See notes below:
    - **Oxygen**: With intense heat and adequate fuel, fires create their own winds which brings in more oxygen.



Ask students to describe common ignition sources.

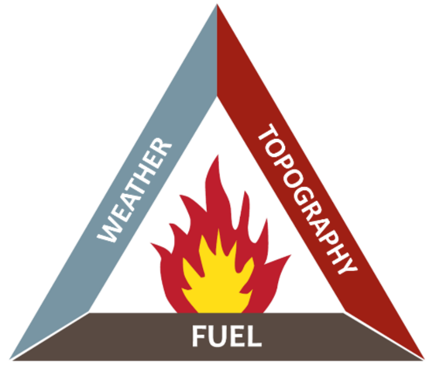
- **Humans**
    - Prescribed fire is an important tool on rangelands; when intentionally ignited and carefully timed and controlled, fire can be used to clean up old, dead trees and brush allowing for new plants to grow, and can also be used to control unwanted plants like junipers which can take over grasslands.
    - Fires that start by accident from fireworks, sparks from vehicles and equipment, target shooting, camp fires, smoking, etc. are not good and destroy a lot of wildlife habitat. Smokey Bear says "Only you can prevent forest fires", and YOU ACTUALLY CAN by being aware of your surroundings and making good choices when you recreate (e.g., if the vegetation is brown and dry, be extra careful of where you are setting off fireworks).
- **Lightening** is the number one, natural cause for wildfires!

Reflect:
If you remove one of the legs of a triangle, will it be a triangle? Just like all three sides are necessary for a triangle, all three components are essential for a fire. Without one of them, a fire will not start.

Fire Behavior Triangle

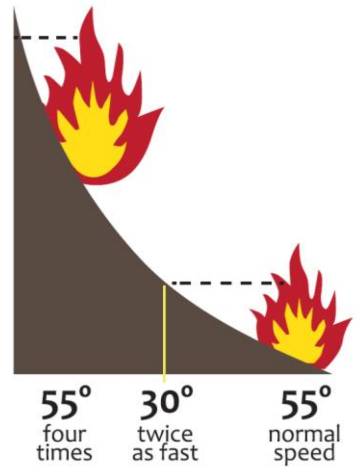
What makes a fire spread fast one day, and slow another day? What makes a wildfire burn "hot" or "cool"? Fuels, weather, and topography all contribute to the behavior of the fire.

Do:
Have students fill in the 3 components of the fire behavior triangle and discuss each component.



- **Fuel:** fuels are any living or dead plant material above the ground's surface that can burn. The amount, arrangement or continuity (e.g., can a flame that is burning one plant, reach another plant?), and fuel moisture (what percentage of the plant is water) all influence fire behavior.
- **Topography:** includes land features like slope and aspect
- (e.g., south/ north side of mountains). Steeper slopes will burn more rapidly, because the fire has more access to oxygen. Fire is further accelerated going uphill because ground fuels are closer to flames as steepness increases (see illustration to the right).
- **Weather:** affects fire because of the humidity (moisture in the air) and temperature of the atmosphere. This affects fuel moistures, which determines how quickly or slowly fuels will ignite and burn. For example, do you sweat more when it is hot or cold? When it is hot and dry, plants lose more water through transpiration than when it's cold and humid.

  Fire also creates its own weather! When the hot air from the fire rises, fresh air rapidly moves in producing wind, bringing more oxygen to the fire.



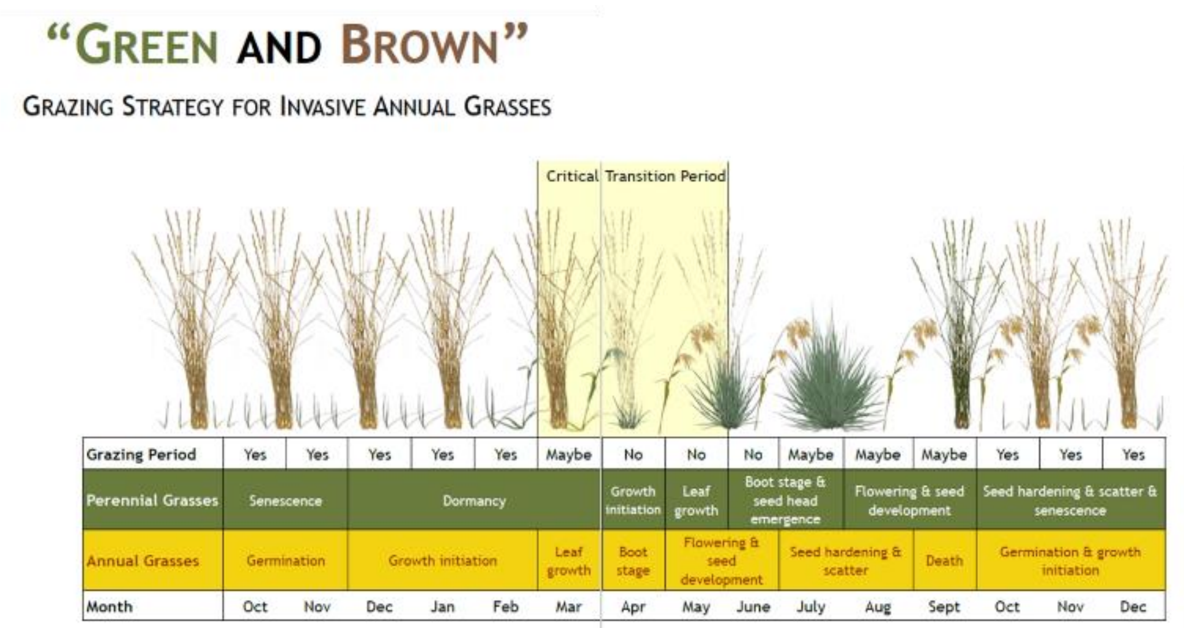
Apply:
- What is the common component between the two triangles? Fuel.
- As a rangeland manager, what component can you manage? Fuel. On rangelands, you can't change topography and you can't control the weather. Most of the time, you can't influence heat (although helping people be aware of fire risk can help!), and you can't control the oxygen. **You CAN MANAGE the FUELS!**

Fuel Management:
Fuel management on rangelands can change fire behavior by affecting the amount of ground fuels and the arrangement (or continuity) of fuels. Some of the different management treatments that can be used to manage fuels include:
- **Prescribed Burning:** this is the intentional application of fire when the weather conditions will not likely lead to an intense fire (often used in the early spring, late fall, or even when there is snow on the ground!). This can change the amount of fuel, and also where fires will or will not burn in the future.
- **Mechanical Treatments:** these treatment involve different mechanized tools to remove plants. Some examples include: tilling, chaining, mowing, and shredding or chipping woody plants. Often times with mechanical treatments, we are not removing fuels, but rather changing the fuel structure. For example, fuels burning on the ground are easier to control than when they are in the canopy of a tree.
- **Herbicides**: chemicals that kill or injure plants.
- **Manual Treatments:** the use of hand tools to remove plants

- **Livestock Grazing:** animals eat plants, which reduces fuel and recycles nutrients as manure. Depending on what your plant community looks like, you can target certain unwanted species (e.g., cheatgrass and medusahead) and have little to no effect on desirable plants like native bunchgrasses.

Do:
More and more research is supporting the use of livestock grazing to reduce fuels (i.e., grasses). One example is the "Grazing Invasive Annual Grasses: The Green and Brown Guide". In this guide, research discuss a simple method for managing livestock to reduce annual grasses while allowing perennial grasses (desired species) to grow. It also illustrates when grazing should be removed. Discuss the "Green and Brown" chart and answer the following questions:

- Annual Grasses should be grazed during what plant growth stages? *Germination and Growth Initiation (the goal is to stop annuals from producing seeds—remember, annuals grow and die the same season).*
- Why is the grazing period a "Maybe" or "No" during certain months? *When Perennial Grasses start to grow (Growth initiation, Leaf growth, Boot stage & seed head emergence, and Flowering & seed development), they are the most vulnerable to damage. Although it's okay to graze plants during those month periodically, you don't want to do it every year. That's one of the reasons we have rotational grazing systems. It allows for perennial grasses to flower and produce seed every few years sustaining the population.*



Grazing Period	Yes	Yes	Yes	Yes	Yes	Maybe	No	No	No	Maybe	Maybe	Maybe	Yes	Yes	Yes
Perennial Grasses	Senescence		Dormancy				Growth initiation	Leaf growth	Boot stage & seed head emergence		Flowering & seed development		Seed hardening & scatter & senescence		
Annual Grasses	Germination		Growth initiation			Leaf growth	Boot stage	Flowering & seed development		Seed hardening & scatter		Death	Germination & growth initiation		
Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec

2. *What Burns Best?*

(Adapted from BLM's Fuels-What Burns Best? lesson)

THIS IS A TEACHER DEMONSTRATION ACTIVITY ONLY, WHEN WORKING WITH FIRE BE AWARE OF YOUR SURROUNDINGS AND HAVE WATER AVAILABLE.

For additional safety precautions, review the Safety Tips below.

Time: 20-25 minutes (plus time to gather plant materials)

Supplies:

- Metal bucket (you can do this activity with 1 bucket or with up to 4)
- Wooden matches (~28; 7 for each bucket)
- Plant materials placed inside labeled bags or boxes (you can also have students gather plant materials)
    - Green grasses and plants
    - Dead/dry grasses and plants (e.g., cheatgrass)
    - Sagebrush
- Large bucket of water
- Spray bottle filled with water
- Access to a hose
- Metal trash can

Background:

In the last section, you learned that immature plants can be made up of 75% water (page 47; FYI: a watermelon is about 92% water!). That's a lot of water! As the summer progresses, plants lose water through transpiration (which is the evaporation of water from plants primarily through pores on the leaves). As plants lose water, they turn from green to brown.

Do: In teams, assemble a mixture of fuels according to one of the recipes below.

ALL FUELS MUST FIT INSIDE THE BUCKETS, WITH NOTHING HANGING OUT OVER THE EDGES.

Use only the fuels included in each recipe, nothing else should be added.

- Have students write a hypothesis (what they think will happen when you drop the match in the bucket) for each recipe in a notebook (or lab book). *Hypothesis are not guesses, instead, students should use what they have learned so far to make an "educated guess" based on that material.*

Recipes:

1. Green grasses or plants (if these are gathered more than a day before the experiment takes place, they should be stored in a plastic bag in the refrigerator).
2. Dead and dry plants
3. Sagebrush
4. Dead and dry plants, but sprayed lightly with water.

- One approach to writing a hypothesis is to use this statement:
  "If ____[I do this]_____, then__[this]__will happen."
    - Example: If I never water my plant, it will dry out and die.
    - Example: If a plant is green (has high fuel moisture), then it will not burn.

- Using the seven matches provided for each bucket, the TEACHER should attempt to light the fuels, one bucket at a time to allow the students to see how each fuel burns.

- Students should write observations in their notebook for each recipe.

- Questions to consider:

    - Did the fuel burn slowly or quickly?
    - Were there big or small flames?
    - Did it just smolder?
    - How much smoke was produced?

Apply:

Students will most likely note that it was difficult to ignite the "green" fuels and the fuels that had been sprayed with water.

- Challenge students to explain why, potential answers:
    - They had more moisture than the other fuels; the heat from the flame first has to evaporate the moisture before it can ignite the fuel.
    - Once the green fuels started burning, they actually burn quite well, why? *They have plenty of stored energy—more, in fact, than dead plant materials. Pine needles also contain oils and other compounds that burn well.*
- Have students compare and contrast the ability of large and small materials to burn.
    - Why would the smaller pieces ignite more easily? *The smaller pieces have more surface areas exposed to the heat of the flame and to oxygen).*

Safety Procedures:

- Notify, in advance, any individual or agencies (principal, local fire protection unit, and/or maintenance staff) that would want to know that your activities involve fire.
- BE AWARE OF YOUR SURROUNDINGS!
- Choose open, well ventilated, debris and vegetation free location for this activity to reduce the chances of fire alarms being triggered.
- Be aware of wind direction and force. Postpone this activity if it is too windy and you will be working outdoors.
- Instruct students on the use of the spray bottles and fully charged fire extinguishers that must be in the activity area. Assign 1-2 students with firefighting duty—they should have spray bottles/hose in hand prior to lighting anything on fire.
- Instruct all students to NOT attempt this activity without an adult present.
- Student and teacher should wear safety goggles; tuck in loose clothes and tie back long hair.
- Have emergency phone numbers readily available
- Inform the students that they should never use fire without an adult present.

3. *Skills Challenge: Matchstick Rangeland*

(Adapted from Forest Service Fire Trunk Activities. You may choose to have each student create a rangeland or work in teams.)

Time: 30-45 minutes

Supplies: Supplies for 1 matchstick rangeland

- 30 wooden matches, toothpicks, or short pieces of wheat straw
- 1 craft Styrofoam block (about 6x6x1")
- 1 aluminum baking pan large enough to place foam block in bottom
- 1-2 water-filled spray bottle
- 1 watch/clock with a second hand
- Hot pads/oven mitts
- Newspaper and scissors
- Safety goggles or eye glasses
- Fire Extinguisher, large bucket of water, and/or access to a hose

This can be done as a demonstration for younger audiences.
IT MUST BE SUPERVISED BY THE TEACHER

Do:

- Review Safety Procedures
- Have each student/team build one of the following rangelands:
    - **Rangeland 1:** Build a matchstick rangeland on a flat slope
    - **Rangeland 2 and 3**: Build a matchstick rangeland on a 20 degree slope (ignition will vary)
    - **Rangeland 3:** Build a matchstick rangeland on a 40 degree slope

Detailed instruction for building a matchstick rangeland:

1. Place aluminum pans on a heat resistant surface (sidewalk, table, etc.)
2. Place the Styrofoam board in the aluminum pan to create a base for the rangeland (you can cover your Styrofoam board with aluminum foil if you plan to do this more than once)
3. Place the untreated ends of the unlit matches into the boards so the tips are about ½ inch apart. (You can also use toothpicks and/or straw for this step).

    For round 1, the same amount of matches (density) should be used in each of the rangelands. Round 2 is described under the "optional" section below.
4. Establish the slope of the matchstick rangeland (to create the slope, find a rock, or piece of wood, etc. to put under one side of the Styrofoam board):
    - Rangeland 1 should be flat
    - Rangeland 2 and 3 should be elevated about 20 degrees (~3-4 inches)
    - Rangeland 4 should be elevated about 40 degrees (~6 inches)
5. Once all have been set-up, bring students together and discuss the next step.
6. Ask students to look at the set-up and predict how and why fire behavior will differ among them based on how they are ignited (write hypothesis in lab book or notebook). Remind them that any inaccurate predictions are celebrated because it shows participants are learning something new.

7. Ignition:
    - Rangeland 1: light the edge row of matches
    - Rangeland 2: light the matches at the bottom edge of the slope
    - Rangeland 3: light the matches at the top of the slope
    - Rangeland 4: light the matches at the bottom edge of the slope
8. Assign one student to be the timekeeper (they will say go when you are ready to ignite the matchstick rangeland) and will stop the timer when there is no longer fire.
9. Light one pan at a time so all students can observe what happens to each model. When the timekeeper says "go," light one row of matches. All students should record the following observations about fire behavior:

    - Density (number) of the fuel (matches)
    - Topography (slope)
    - Point of ignition (i.e., bottom or top of the slope)
    - Time to burn
    - The density of unburned matches
    - Any other observations to explain fire behavior

Apply:

After all the rangelands have been set on fire, have the team members share their observations of different fire behavior.

Discussion Questions:

- How did the slope affect each fire's spread?
- How well did fire burn downhill?

Optional: After you have completed the activity, have students create their own scenarios. For example, students could adjust how matchsticks are placed (perhaps there has been a fuels treatment that removed sagebrush (i.e., matchsticks) from a portion of the rangeland). Perhaps there are invasive annual grasses creating a continuous fuel load (e.g., this can be mimicked using shredded newspaper or dried plants). Students may want to adjust the ignition source (e.g., unsupervised campfire), or perhaps they will use grazing to create a fuel break. The possibilities are endless.