S-190 Unit 2: Fuels

Summary:

Fuels are the main element of the fire triangle that can be manipulated by firefighters. Distinct characteristics of fuel will affect fire behavior, decision making on the fireline, and actions in their removal.

Incident Position Description (IPD) Alignment:

This unit aligns with the following FFT2 IPD specific duties (https://www.nwcg.gov/positions/fft2/position-ipd):

- Apply the knowledge of fuels, terrain, weather, and fire behavior to decisions and actions.

Objectives:

Students will be able to:

- Describe the term fuels.
- Describe how fuel type and fuel characteristics affect fire behavior.

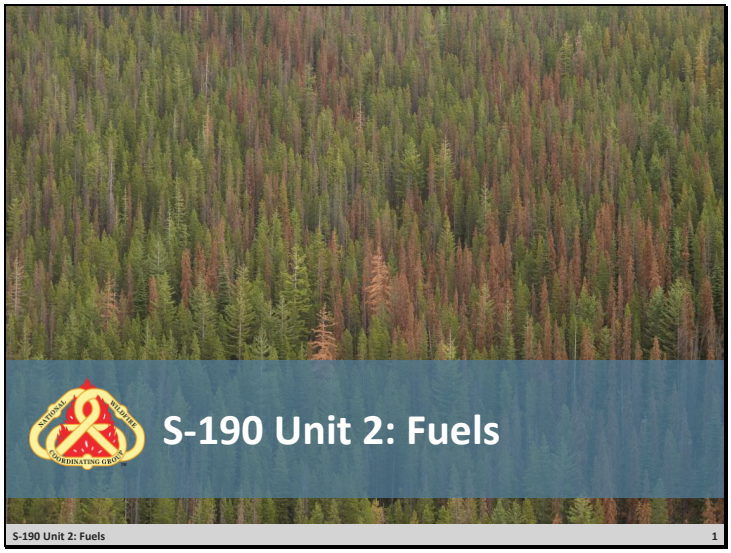
Unit at a Glance:

Topic	Method	Duration
Unit Introduction	Presentation	5 Minutes
Definition of Fuel	Presentation	5 Minutes
Fuel Type	Presentation	20 Minutes
Fuel Characteristics	Presentation	30 Minutes
Total Unit Duration		**60 Minutes**

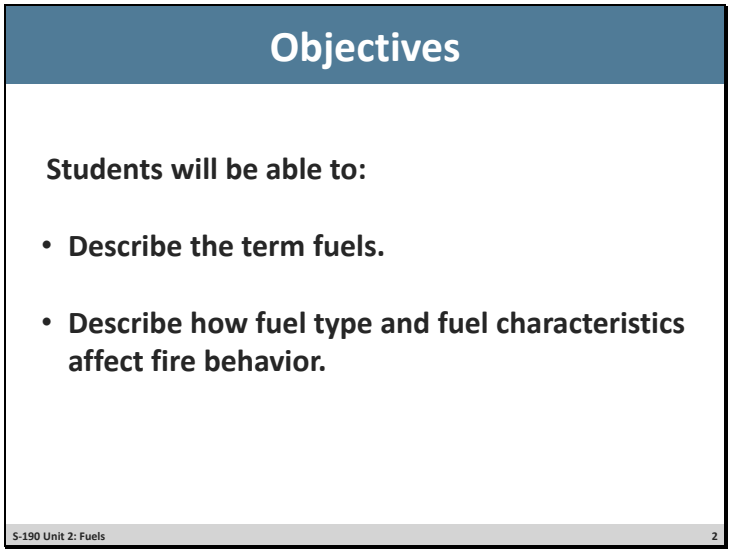
Materials:

- *Incident Response Pocket Guide (IRPG)*, PMS 461, https://www.nwcg.gov/publications/461.
- *NWCG Glossary of Wildland Fire*, PMS 205, https://www.nwcg.gov/glossary/a-z.
- Notebooks for participants.
- Ability to display images and video on large screen.
- White board or easel access for group breakout.

Slide 1

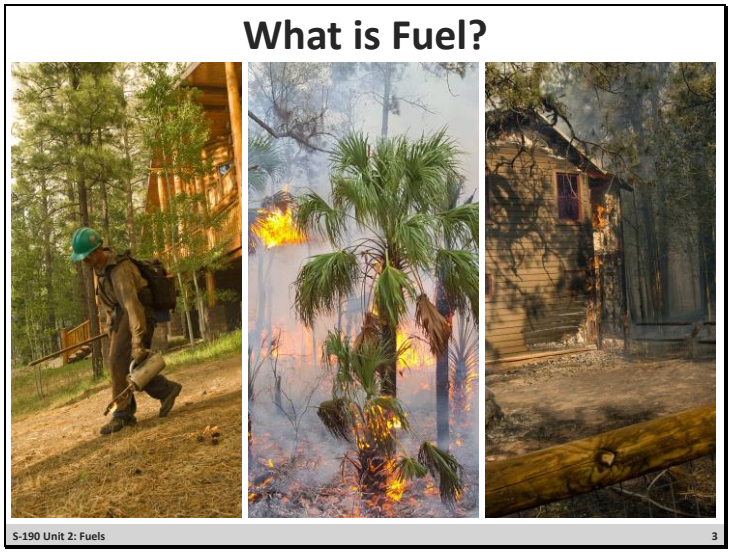


Slide 2



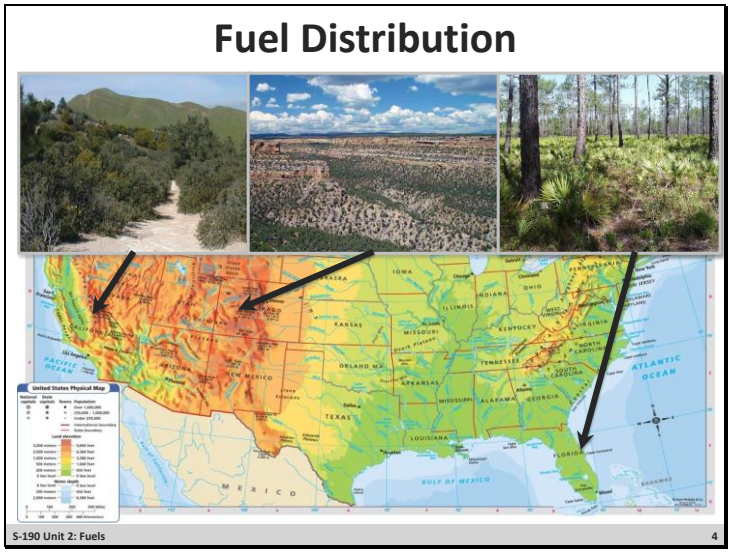
❑ Review unit objectives.

Slide 3



- Fuel is the material that is burning. It can be any kind of combustible material, especially petroleum-based products, and wildland fuels.
- For wildland fire, it is usually live, or dead plant material, but can also include artificial materials.
- Artificial materials are items such as houses, sheds, fences, pipelines, and trash piles.

Slide 4



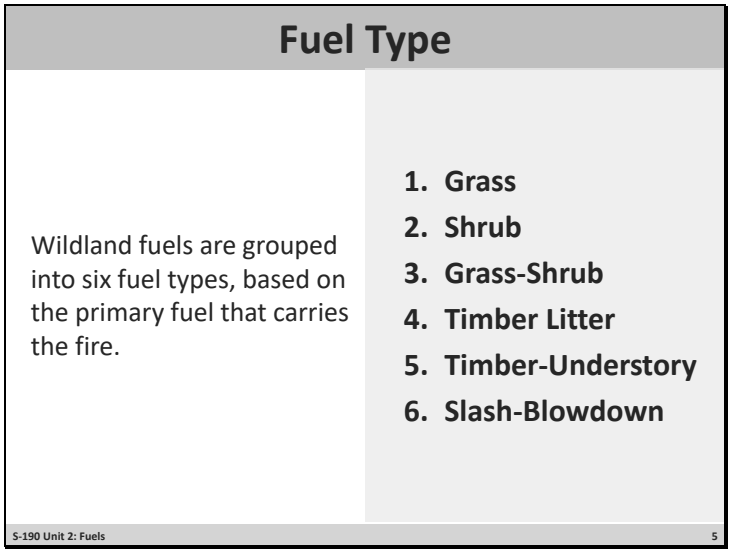
- Firefighters can be called to respond to incidents in different parts of the country, climate zones, and fuel types.
- There are geographic and regional distinctions across the country in regards to the predominate fuel types in the area.
- The amount of water in the soil and elevation change are some of the reasons behind different fuel types.

Note to Instructor

- Image on left: Manzanita in southern California.
- Image in middle: Pinyon-juniper woodlands in Colorado Basin.
- Image on right: Palmetto in central Florida.

❑ Describe primary fuel distribution in the area where the class is being presented.

Slide 5



Definition

Fuel Type: An identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause a predictable rate of spread or resistance to control under specified weather conditions.

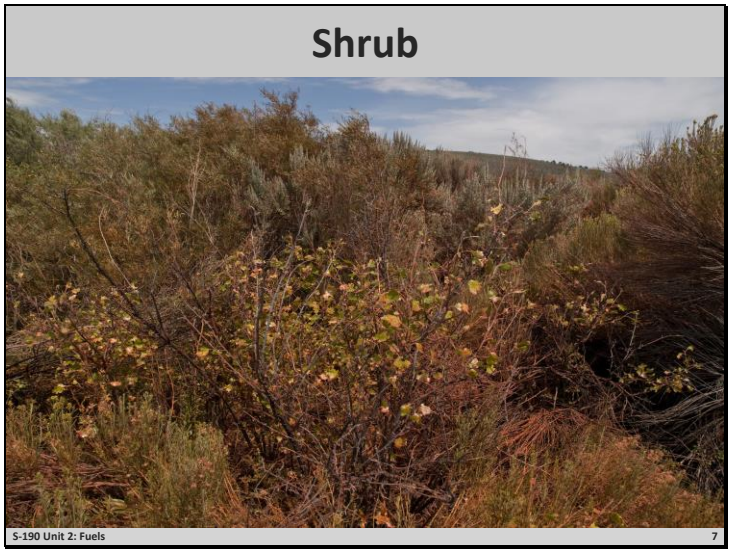
- Man-made fuels are referred to as artificial fuels in the wildland fire context.

❑ Reference Common Denominators of Fire Behavior on Tragedy Fires in the *Incident Response Pocket Guide (IRPG)*, PMS 461, https://www.nwcg.gov/publications/461.

Slide 6

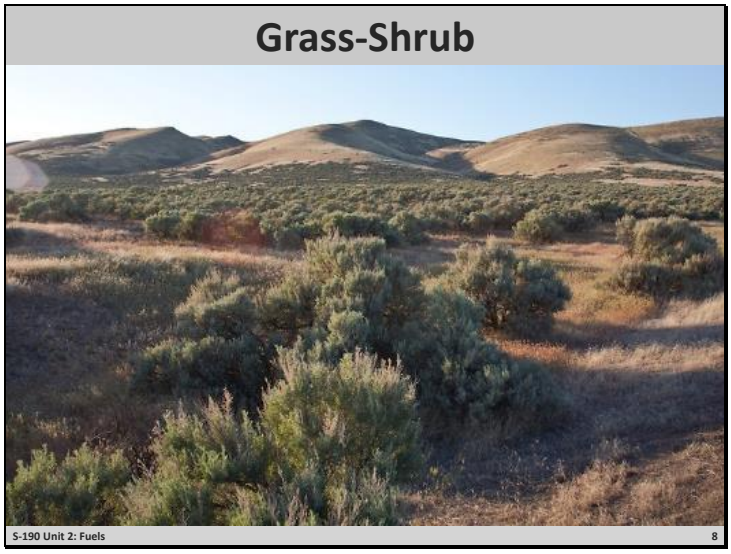
- Located in all regions of the country, grass is the predominant fuel found in desert and range regions.
- Responds quickly to wind and changes in relative humidity, and burns the fastest of the fuel types. It is common to hear the term wind-driven when referring to grass fires, due to the impact wind can have on this fuel.
- Fire can spread very quickly, but can also burn out very quickly, leaving areas safe to move through just seconds after the flaming front passes.
- Potential to become the prevalent fuel in an area after a fire has occurred. For example, after a fire in timber, grass will regenerate first, introducing a new predominate fuel to that area.

Slide 7



- Shrubs are found in most regions and include some low-growing trees, such as scrub oaks.
- May burn very actively, or may slow the spread of fire depending on type of shrub and time of year.
- The shrub type is highly influenced by drought conditions.
- When the shrub type is receptive, it has the potential to spread fire quickly.

Slide 8

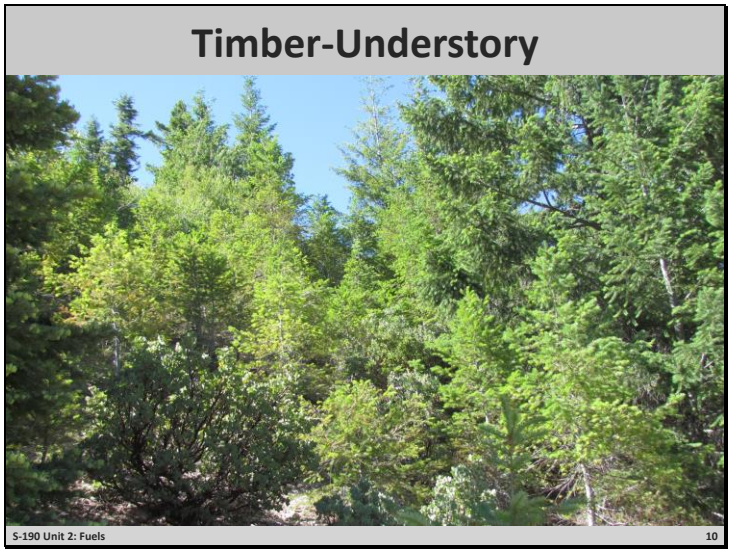


- Commonly found in the plains regions and high deserts, grass-shrub is a mixture of fine grass and shrubs.
- Fire behavior in this type combines the features of the grass fuel type and the shrub fuel type.
- Fires may spread rapidly with wind, but more slowly than a grass fuel type.
- Shrubs add intensity to the fire and may produce spotting, but fires are less intense than in the Shrub type.
- Where it may be safe to move in the grass type immediately after fire passes, it may not be safe in this type because of longer-burning shrubs.

Slide 9

- Timber litter refers to dead leaves, needles, and twigs on the forest floor.
- Fires generally move more slowly in timber types than in grass or shrubs, but burn for longer, and are harder to control.
- When fires burn through the upper canopy of trees they can move very quickly and with extreme intensity.

Slide 10



- Timber-understory refers to a canopy of trees with other plants (such as shrubs and small trees) growing below them.
- Fires in this type combine the features of the timber litter type and the shrub type, moving faster than fires in timber litter, but burning longer than fires in shrubs.
- Fires in this fuel type can move very quickly and with intensity, especially when understory trees/shrubs act as a ladder for fire to climb into the upper canopy.

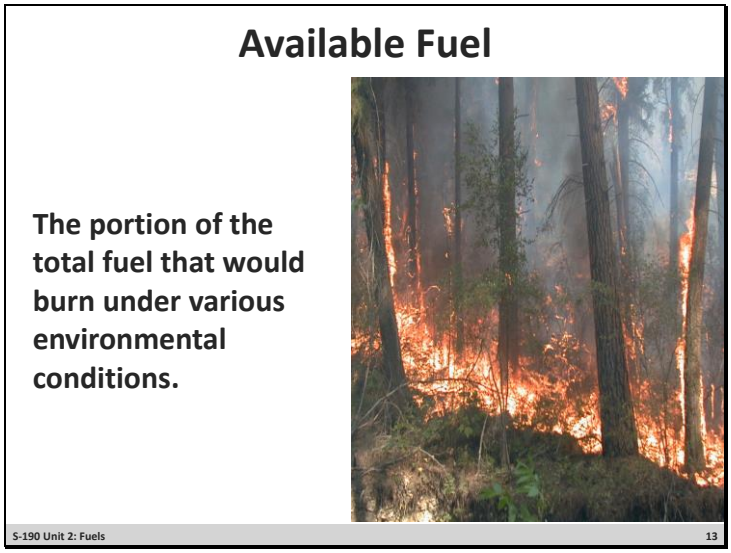
Slide 11

- Slash-blowdown is debris resulting from such natural events as wind, fire, or snow breakage, or human activities such as road construction, logging, pruning, thinning, or brush cutting.
- Fire in this fuel type does not commonly spread quickly. However, due to the sheer amount of fuel that is available, a fire that is established in this fuel type can be very intense and difficult to extinguish.
- Slash typically includes:
  - Logs.
  - Chunks of wood.
  - Bark.
  - Branches.
  - Stumps.
  - Broken understory trees or brush.

Slide 12

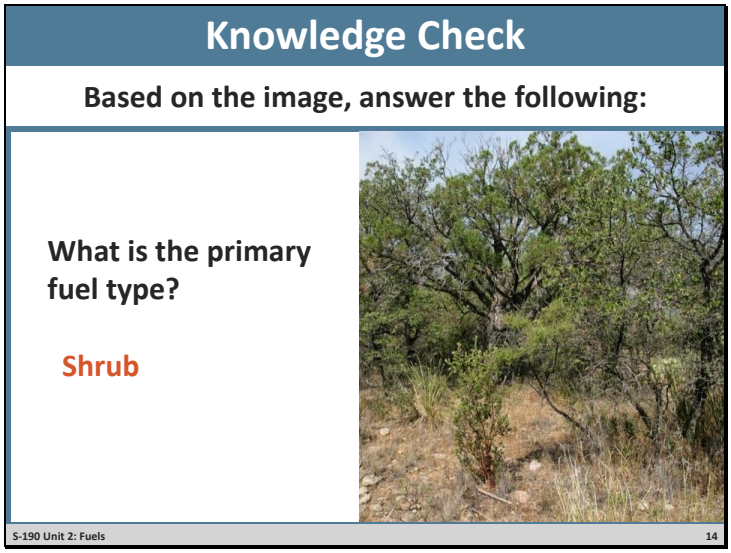
- Although not necessarily considered a fuel type, artificial, or constructed fuels are often present in the wildland environment.
- In many cases, the location of artificial fuels, such as trash piles, or drug production facilities, is unknown until discovered by firefighters.
- Examples of artificial or constructed fuels include:
  - Houses.
  - Vehicles.
  - Tires.
  - Trash.
  - Log decks.
  - Above ground oil and natural gas pipelines.
- Artificial or constructed fuels can present special hazards, such as toxic chemicals, and explosion potential, to wildland firefighters.

Slide 13



- Fuels availability for combustion is dependent on its characteristics. However, species of the plant, its age, and the time of year are other important factors.
- For dead fuels, fuel moisture content depends on how much moisture is in the environment and how quickly the fuel absorbs or loses moisture.

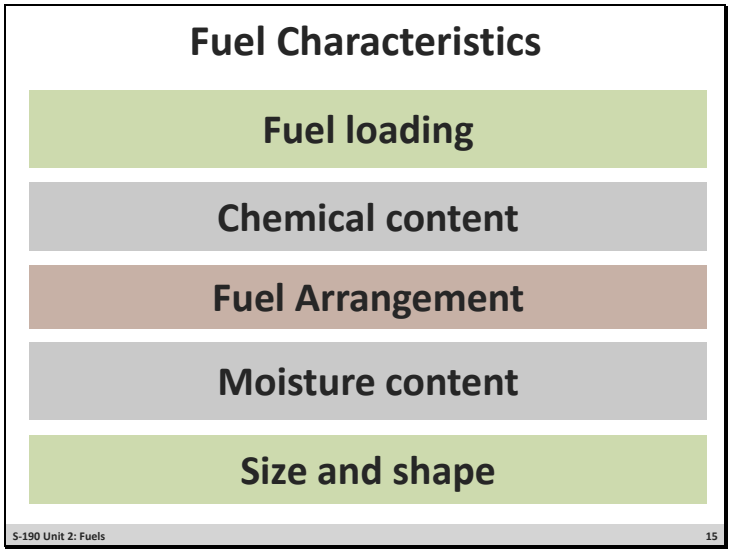
Slide 14



Question: What is the primary fuel type?

Answer: Shrub

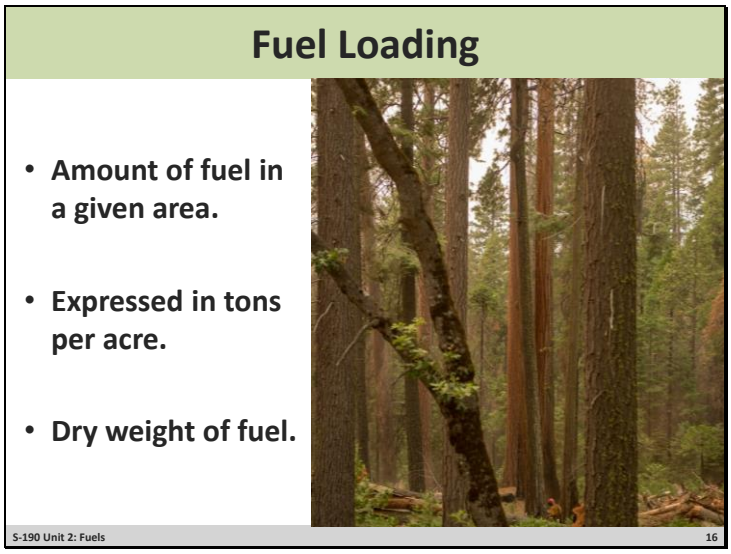
Slide 15



- Fuel characteristics influence how fires typically behave.
- The different fuel types can vary in behavior due to their specific characteristics.
- Example: A timber fuel type in the Pacific Northwest region may have different characteristics than the same timber fuel type in the Eastern region.
- Identifying fuel characteristics can give an estimated prediction of fire behavior.
    - Reference Look Up, Down and Around in the *Incident Response Pocket Guide (IRPG)*, PMS 461, https://www.nwcg.gov/publications/461.

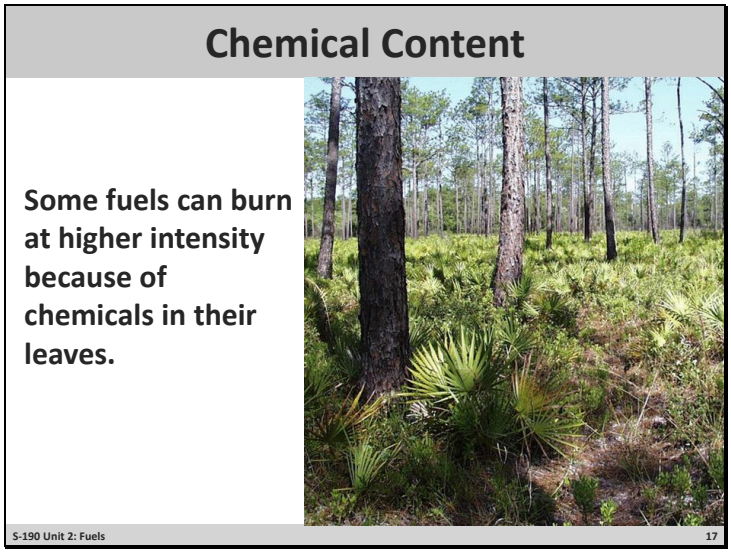
Note to Instructor
The five categories of fuel characteristics will be discussed separately on slides 16-29.

Slide 16



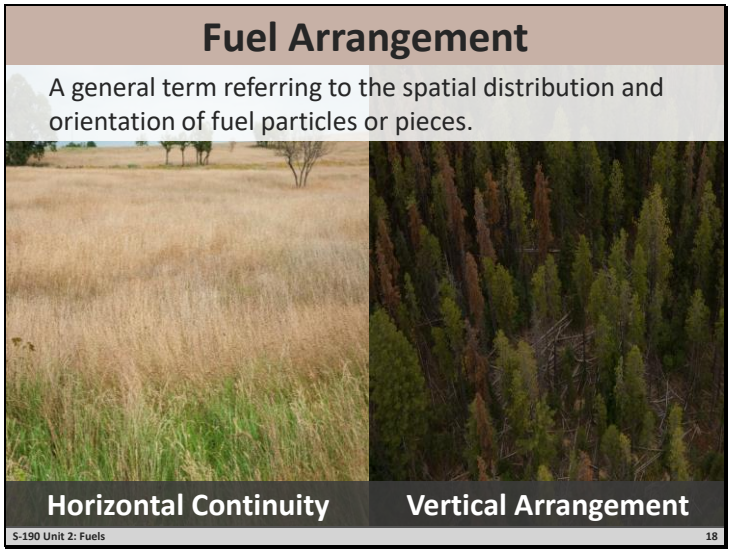
- The amount of fuel present expressed quantitatively in terms of weight of fuel per unit area. This may be available fuel (consumable fuel) or total fuel and is usually dry weight.
- Dry weight of fuels refers to what the fuels would weigh dry.
- The loading of fuels in any given area does not necessarily mean that fire will burn with great intensity.

Slide 17



- Chemical content refers to the presence of substances in the fuel such as:
  - Oils
  - Resins
  - Wax
  - Pitch
- Fuels with high amounts of these substances can contribute to rapid rates of spread and high fire intensities.
- Some well known fuels in which these substances exist are:
  - Palmetto in the Southeast.
  - Tamarisk in the Southwest.
  - Many of the chaparral shrubs found in California.

Slide 18

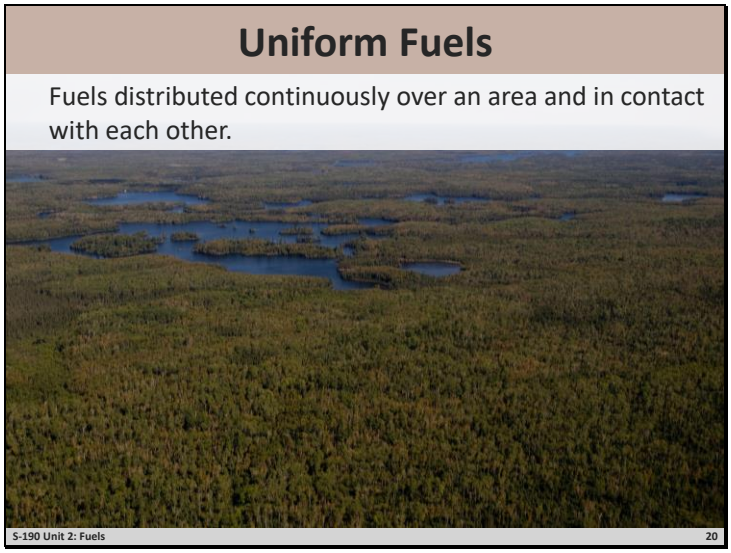


- Fuel arrangement is divided into two primary categories:
  1. Horizontal Continuity.
  2. Vertical Arrangement.
- Fuel Continuity is the degree or extent of continuous or uninterrupted distribution of fuel particles in a fuel bed thus affecting a fire's ability to sustain combustion and spread. This applies to aerial fuels as well as surface fuels.

Slide 19

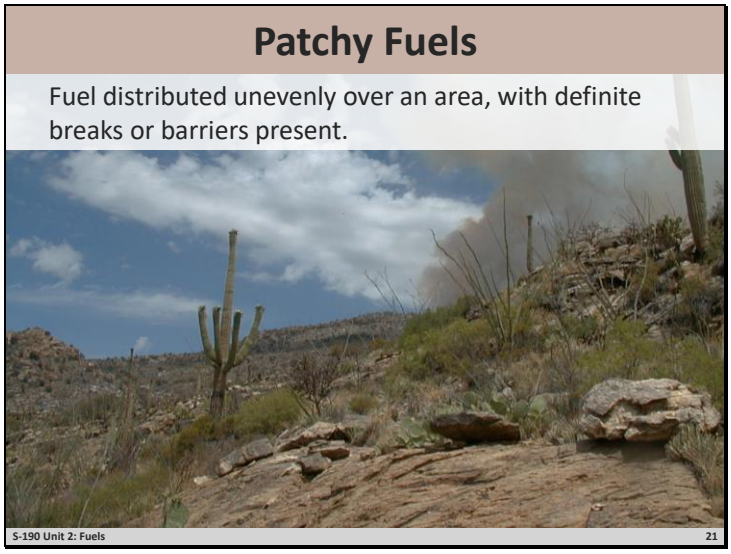
- Horizontal, continuous fuels are closely packed and in direct contact with one another.
- Two main categories:
  1. Uniform Fuels.
  2. Patchy Fuels.

Slide 20



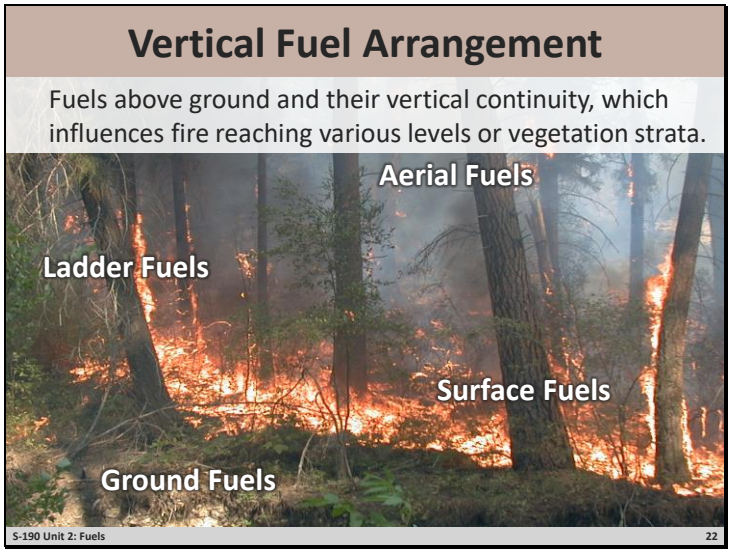
- Uniform, continuous fuels describe areas containing a network of connected fuels, allowing a continuous path for fire to spread.
- The fuels affect the rate of ignition and spread potential by allowing fire to move steadily from one piece of fuel to the next.

Slide 21



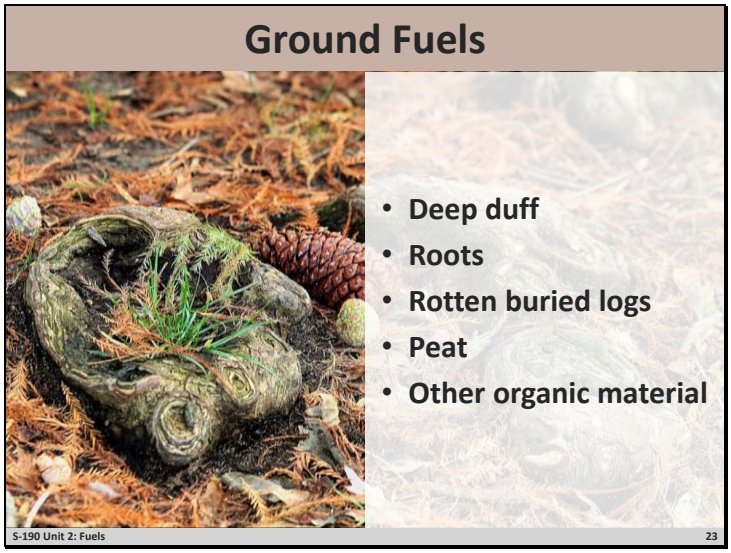
- Refers to areas where the horizontal continuity is disrupted by things like:
  - Rocks.
  - Bare dirt.
  - An intermixing with a fuel type that is much less flammable, such as green grass, or aspen trees.

Slide 22



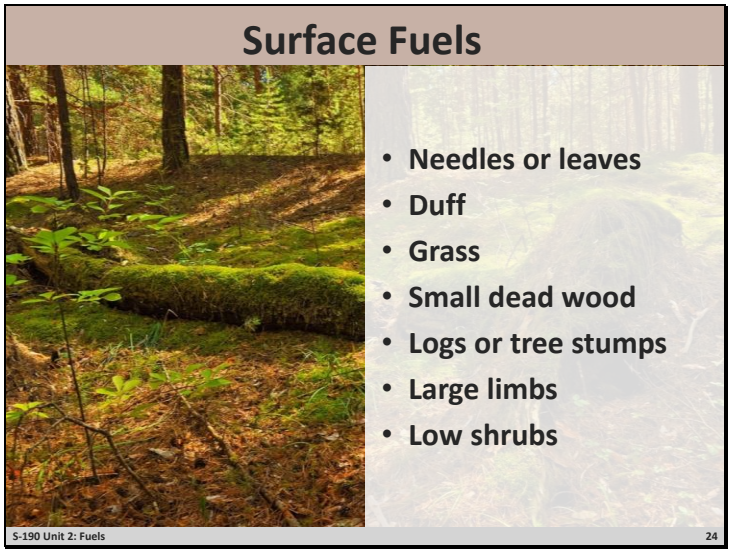
- Vertical arrangement of fuels is broken into four categories:
  1. Ground fuels.
  2. Surface fuels.
  3. Ladder fuels.
  4. Aerial fuels.

Slide 23



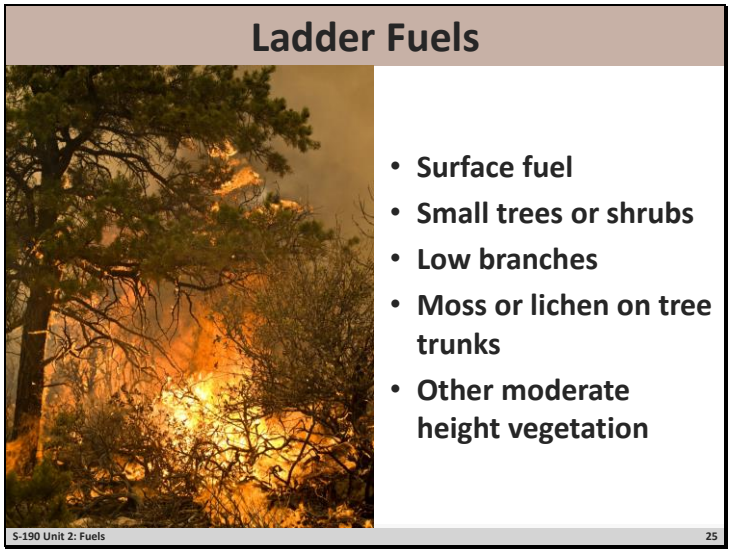
- All combustible materials below the surface litter, including duff, tree, or shrub roots, punky wood, peat, and sawdust, which normally support a glowing combustion without flame.
- Ground fuels do not spread fire quickly, but they can pose problems for containing fires.
- Ground fuels burn below the surface of the ground, out of sight, making it difficult to detect. They can burn for extended periods–weeks, and, in some cases, years.
- Smoldering ground fuels can burn underneath fireline and cause fires to spread out of containment lines.

Slide 24



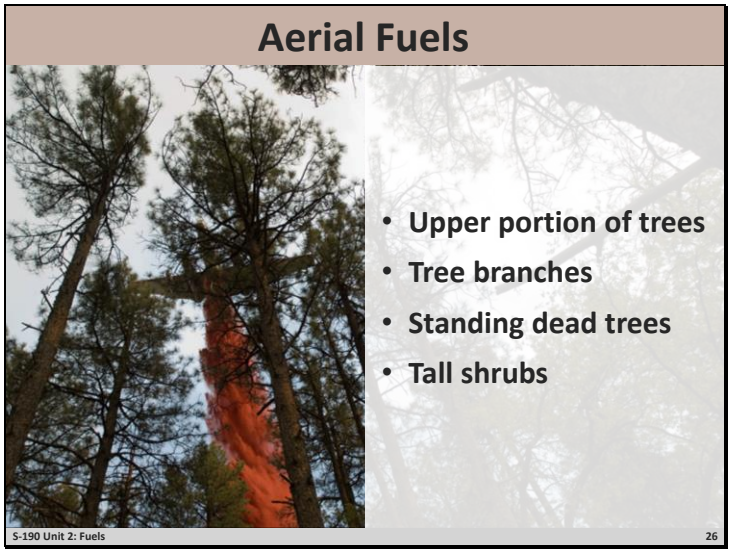
- Fuels lying on or near the surface of the ground, consisting of leaf, and needle litter, dead branch material, downed logs, bark, tree cones, and low stature living plants.
- Includes most of the material we think about as fuel for wildland fires and are the primary carriers of fire once ignition has occurred.
- The primary fuel to remove to break the fire triangle.

Slide 25



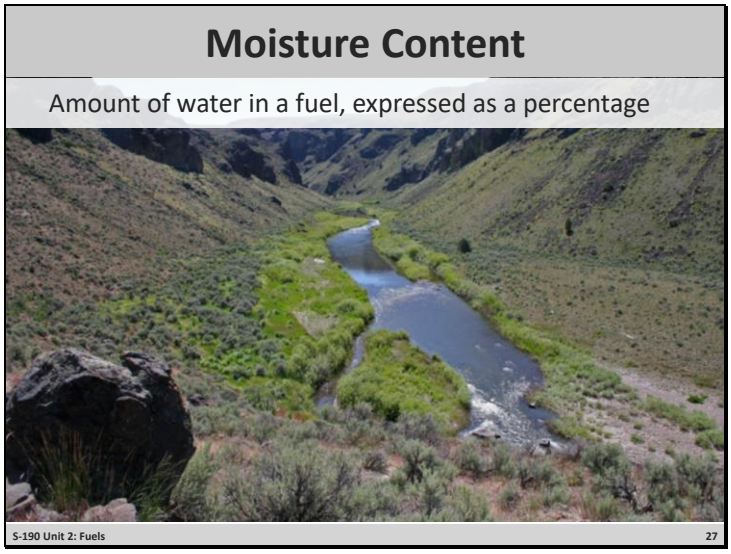
- Fuels that provide vertical continuity between strata, thereby allowing fire to carry from surface fuels into the crowns of trees or shrubs with relative ease. They help initiate and assure the continuation of crowning.
- Ladder fuels allow fires to move from surface fuels, where firefighters are most effective at stopping fires, to burning in aerial fuels where firefighters are not effective at stopping fire.

Slide 26



- Standing and supported live and dead combustibles not in direct contact with the ground and consisting mainly of foliage, twigs, branches, stems, cones, bark, and vines.
- Often referred to as canopy or crown fuels.
- Suppression tactics or tools are not very effective at stopping fires burning through aerial fuels (crown fires).
- Fires moving through aerial fuels (crown fires) can be extremely intense and rapid. Embers from crown fires can travel more than a mile ahead of the fire and perpetuate fire growth.

Slide 27



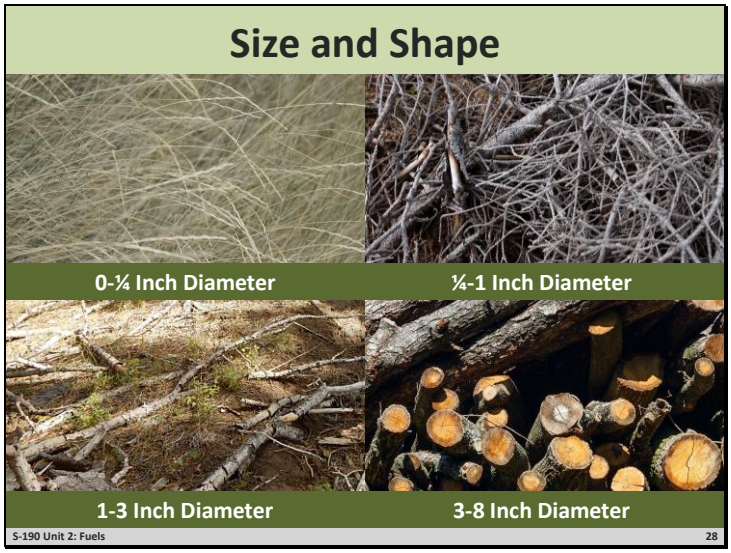
- ❑ Moisture content is the single most important factor in determining how well a fuel will ignite and burn.

Two categories:

1. Live Fuel – Living plants, such as trees, grasses, and shrubs. The moisture content in live fuels is controlled by plant species, age of the plant, time of year, and drought conditions.
2. Dead Fuel – Fuels with no living tissue. The moisture content in dead fuels is controlled by humidity, precipitation, sunlight, wind, and the size, and shape.

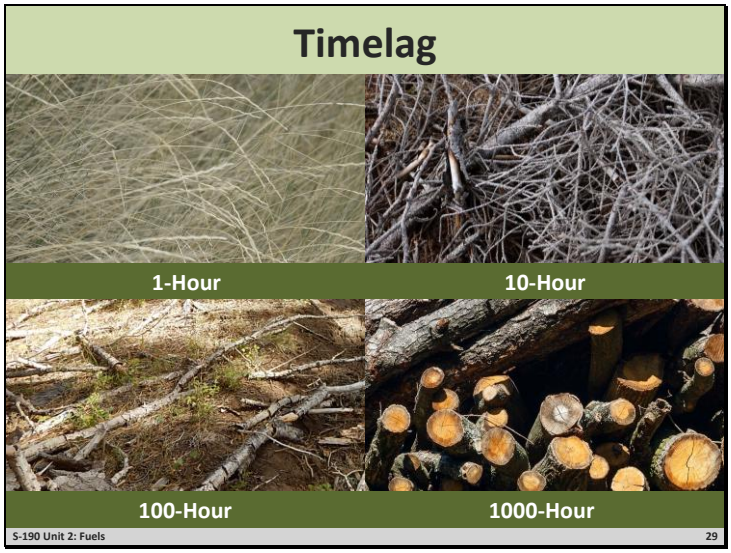
- In general, at the height of the growing season, live fuel moistures will be at their highest and will progressively decrease throughout the fire season, whereas dead fuel moistures can fluctuate frequently throughout the fire season based on immediate precipitation, relative humidity, and sunlight.
- Due to variations in characteristics, as well as size, different fuels located in the same area will have varying moisture levels.
- The drier a fuel is, the more likely it is to catch fire and the hotter it will burn.

Slide 28



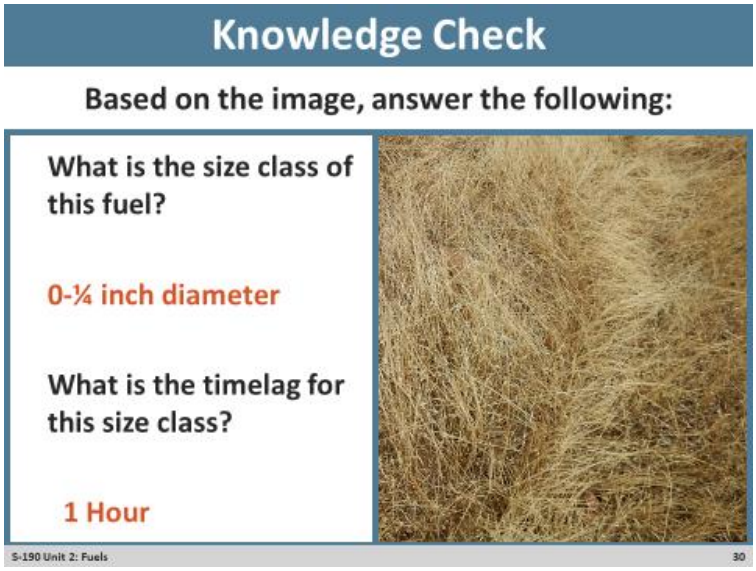
- For dead fuels, the size and shape of a fuel determines how the fuel reacts to its environment and how long it takes to dry out or absorb moisture.
- Size and shape classifications are:
  - 0–1/4” diameter
  - 1/4”–1” diameter
  - 1”–3” diameter
  - 3”–8” diameter
- Fuels within the same size class are assumed to have similar drying and wetting properties, as well as preheating, and ignite at similar rates during the combustion process.
- Smaller fuels dry out and or absorb moisture faster than larger fuels.

Slide 29



- Size and shape classifications correspond to the time it takes a piece of fuel to change its moisture content to match its environment.
- This time period is referred to as timelag, which is the rate at which dead fuel gains or loses moisture.
- Timelag rate classifications are:
  - Fuels 0–1/4” in diameter = 1 hour.
  - Fuels 1/4”–1” in diameter = 10 hours.
  - Fuels 1”–3” in diameter = 100 hours.
  - Fuels 3”–8” in diameter = 1000 hours.
- Example: Fuels that are 0–1/4” in diameter take one hour to change moisture content from where it started to that of the surrounding environment. Whereas, fuels that are 1”–3” in diameter will take one-hundred hours.
- Fuels larger than 8” in diameter are also classified as 1000 hour fuels.

Slide 30



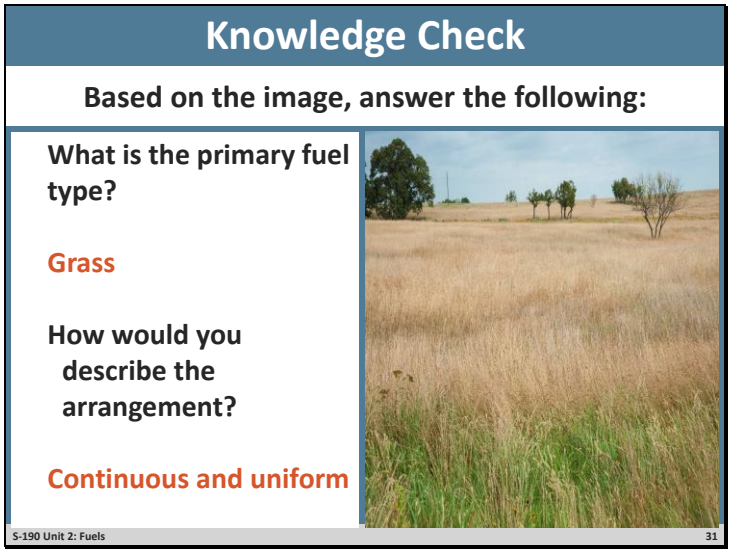
Question: What is the size class of this fuel?

Answer: 0-¼ Inch Diameter

Question: What is the timelag for this size class?

Answer: 1-Hour

Slide 31



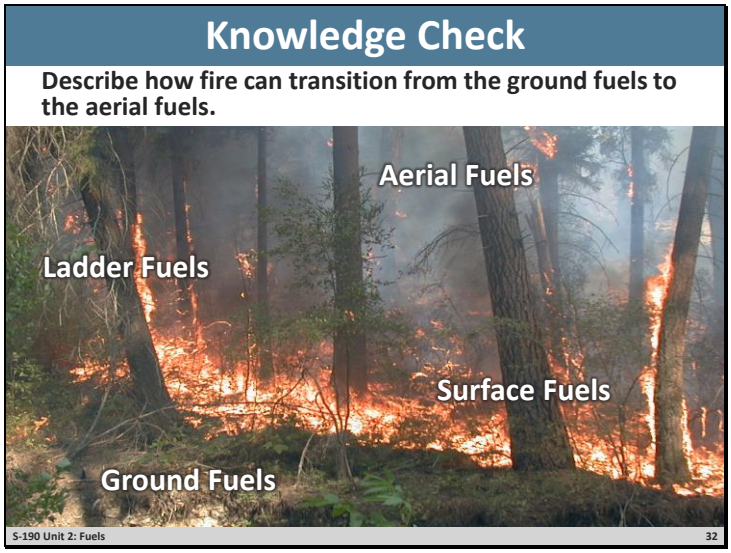
Question: What is the primary fuel type?

Answer: Grass

Question: How would you describe the arrangement?

Answer: Continuous and uniform.

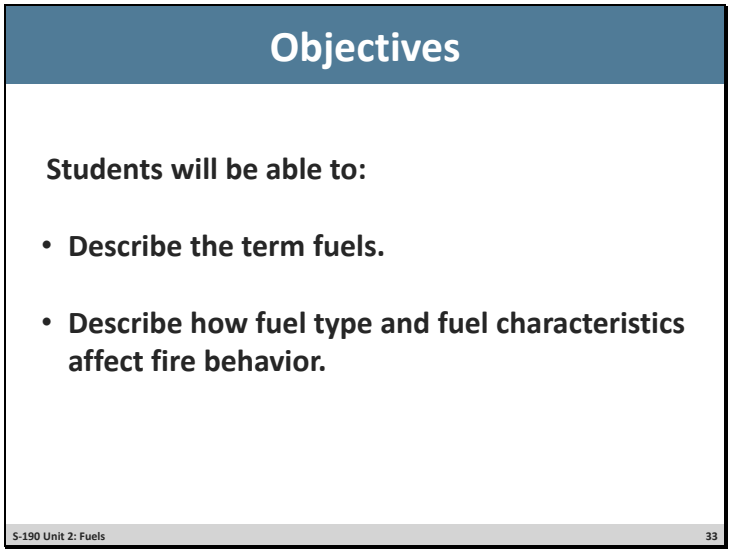
Slide 32



Question: Describe how fire can transition from the ground fuels to the aerial fuels.

Answer: Fire becomes established in the ground fuels, spreads into the surface fuels, transitions into the ladder fuels, and reaches the aerial fuels.

Slide 33



❑ Review unit objectives.