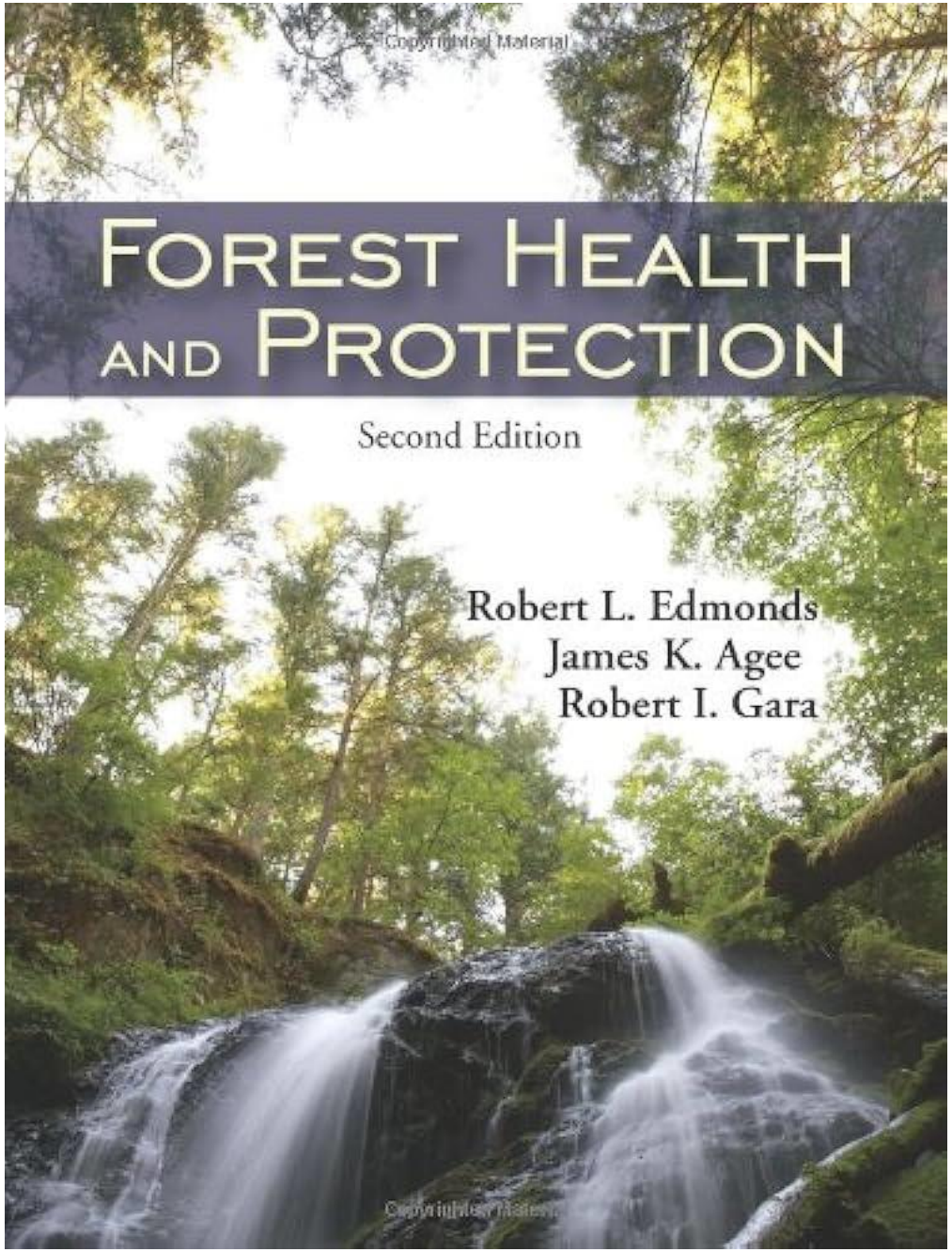

Lect. Ph.D. Dr. Zana Abubakr Ahmed Lak. Forest Ecophysiology

Fire as a Physical Process

- ✓ Wildland fire is a natural process that has many forest health implications.
- ✓ Fires in some ecosystems were essential regulating processes that maintained forest health, whereas in other ecosystems fires created forest health problems.

The Elements of Fire Behavior

- ✓ Fires need fuel, heat, and oxygen to sustain the process of combustion .
- ✓ The fire triangle includes these three "legs" of combustion.
- ✓ The combustion process includes four major phases: preheating, flaming combustion, charcoal combustion, and cooling
- ✓ In the preheating phase, heat is applied to fuel particles and raises their temperature, volatilizing gases that escape.
- ✓ In the presence of oxygen, these burning gases will produce flaming combustion.
- ✓ As most of the gases escape, charcoal combustion at the surface of the fuel particle will create glowing combustion, or smoldering. The cooling phase completes the combustion process.
- ✓ Most fire suppression strategies are designed to remove at least one of the three "legs" of the fire triangle. Fire lines remove fuel; water and aerial fire retardants remove heat and oxygen.

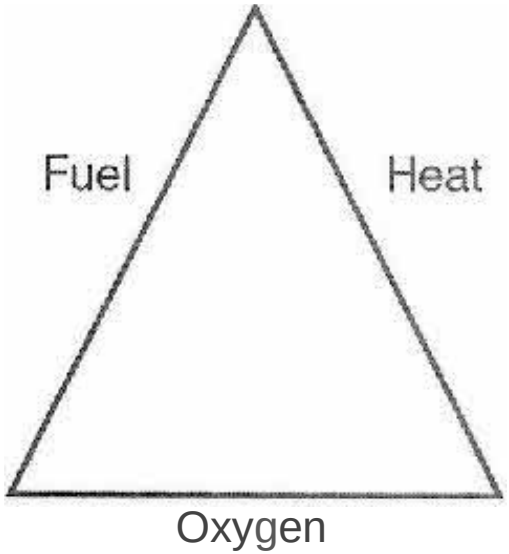

Figure 3.1

The combustion fire triangle. The combustion process requires each leg of the triangle, and all fire suppression efforts are an attempt to remove one of the legs of the triangle.

- ✓ Heat transfer occurs through four processes: radiation, convection, conduction, and mass transfer .
- ✓ Radiation is heat transmitted through electromagnetic wave motion and is the typical warming heat received from a fireplace.
- ✓ Convective heat is that transferred through currents in liquids or gases; the movement of hot air up into tree canopies is largely a convective process.
- ✓ Conduction is the movement of heat from one molecule to another; soil and cambial heating are modeled as conductive processes.
- ✓ Mass transfer is the movement of heat by active firebrands, called spotting.
- ✓ If heat transfer by one of these processes is sufficient, and adequate amounts of fuel and oxygen are present, the combustion process will continue.
- ✓ The combustion process varies tremendously, both in terms of its rate of spread across the landscape and in terms of the rates at which energy is released.
- ✓ These characteristics of fire are known as fire behavior, and they are a function of the sides of the fire behavior triangle: weather, fuels, and topography.

Fuels

- ✓ All fuel is a form of stored energy from the sun.
- ✓ This chemical energy may be released in several ways.
- ✓ It may be decomposed by microorganisms, generally so slowly that the oxidation process does not create significant heat energy.
- ✓ Occasionally, if the decomposing biomass is sufficiently insulated, such as a tightly packed pile of fresh hay, enough heat will be retained that spontaneous combustion results.
- ✓ Fire is simply a rapid form of decomposition, in some cases releasing centuries of chemical energy storage in a matter of minutes.
- ✓ Fuels vary widely in their ability to burn, as they have different amounts of chemical energy; for example, pitch has about 50% more energy per gram than foliage or wood, and all fuels have noncombustible mineral content that leaves the ash seen after "complete" combustion.

Predicting Tree Mortality from Fire

- ✓ When a crown fire burns across a stand, most conifers are killed and many hardwood species will either be top-killed or have to resprout a new crown.
- ✓ Fires of lower intensity will have selective effects, different by tree species and size classes.
- ✓ A conifer has three primary ways it may be injured by fire: crown scorch, cambial heating through bark, and root heating .
- ✓ Each type of damage is predicated on the general rule that tissue death occurs at 60°C for a I-minute duration, although higher temperatures require shorter times, and lower temperatures also will cause tissue death if extended longer .

Fire Management

Fire risk is defined as the chance of a fire starting. With little or no risk, the fire management problem is minimal. Where risk increases, intensified fire prevention and detection efforts are likely to be very cost-effective.

Fire hazard can be generally defined as the amount, condition, and structure of fuels that will burn if a fire enters an area. Hazard reduction through management such as prescribed fire may be an effective way to decrease the fire management problem.

Fire values are the net change in resource condition when a fire occurs.

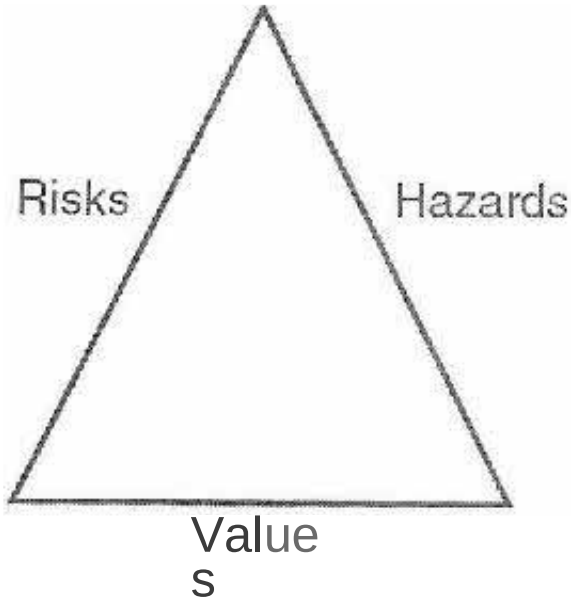

Figure 5.1

The fire management triangle. Most fire management programs are designed to balance the risks, hazards, and values within the planning area.

Direct attack

- ✓ is commonly used as part of the initial attack process. It is an aggressive tactic designed to put most of the effort right at the edge of the wildland fire and hopefully control it while very small.
- ✓ Three basic direct attack tactics are commonly used .
- ✓ The first is frontal attack, also known as "hitting the head" of the fire. The intent is to slow the spread of the fire along the perimeter where it is likely to be moving the fastest.
- ✓ This can be dangerous and generally is attempted by experienced crews only.
- ✓ Successful pinching off the rapidly moving head of the fire allows construction of a fire line along the more slowly spreading flanks and rear of the fire.
- ✓ Flanking attack is a second direct control tactic, and proceeds by starting at the backside of the fire and building a fire line along the flanks toward the head of the fire.
- ✓ This usually is a safer environment for crews, particularly if they are inexperienced. The third direct control tactic is hot spotting, or hitting the vital points of fire spread first, and tying these portions of a fire line together later.

Indirect attack

- ✓ is a tactic that attempts to achieve control by backing off the edge of the fire and establishing a Fireline in places firefighters are most likely to successfully hold as the fire approaches.
- ✓ From a safety perspective, or when fires are crowning, direct control is simply not possible or effective. Trails, roads, streams, meadows, or other breaks in fuel or terrain are likely places for control to be most effective.