# Rocky Mountain

National Park Service
U.S. Department of Interior
Rocky Mountain National Park

# Fire Ecology Teacher Guide

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# Rocky Mountain National Park

Rocky Mountain National Park (RMNP) is defined by the rugged Rocky Mountains that cut through the heart of the park from north to south. These mountains have shaped the landscape and created the conditions for the ecosystems we find within the park. Three of the park's ecosystems, the montane, subalpine, and alpine tundra are delineated by elevation, with the montane ecosystem comprising the lowest elevations in the park (5,600 – 9,500 ft.) and the alpine tundra ecosystem comprising the highest elevations in the park (11,000 – 14,259 ft.). This fragile alpine tundra, which comprises 1/3 of the park, is one of the main scenic and scientific features for which the park was established and is one of the largest and best preserved examples of this ecosystem in the lower 48 states.

Environmental Education was formalized at RMNP with the inception of the Heart of the Rockies program in 1992. Our curriculum is built on the principles of RMNP's founding father, Enos Mills. Mills felt children should be given the opportunity to explore and learn in the outdoors for nature is the world's greatest teacher. A belief that is kept alive today through every education program.

RMNP was established on January 26, 1915 through the efforts of local residents, especially Enos Mills, Abner Spague, and F.O. Stanley. Today the park covers 415 square miles of beautiful terrain, most of which is designated Wilderness.

*Lessons Written and Compiled By*
*Rocky Mountain National Park Environmental Education Staff*
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*Teacher Guide Created by Jessica Rogner 10/2012 and Holly Nickel 5/2013*

# Teacher Guides

Teacher guides have been developed by the education staff at RMNP and each focuses on a topic of significance to the Park. These guides serve as an introductory resource to the topic and the information provided is used by park educators to develop curriculum based education programs. Guides benefit teachers by providing the background information necessary to build a strong foundation for teaching students about specific park related topics; they may also be used as a resource for preparing students for field trips to RMNP. Each guide contains a resources and references section to provide for more in-depth study.

## Rocky Mountain National Park Education Program Goals

1. Increase accessibility to Rocky Mountain National Park for students from our gateway communities and under-served students who otherwise would not have the opportunity to visit the park.

2. Develop a variety of internal and external partnerships with other park operations, school districts, universities, professional educational organizations, agencies, friends groups, and various funding organizations.

3. Conduct workshops to train teachers to take a larger role in their student's experience at Rocky Mountain National Park.

4. Develop distance learning opportunities to serve students from outside our visiting area.

# Schedule an Education Program with a Ranger

Field trips to national parks offer unique opportunities for studying and experiencing natural and cultural resources. Field trips are a great way to make abstract concepts from the classroom concrete. RMNP is an ideal outdoor classroom. It has a diversity of natural resources, easy spring and fall access, and is in close proximity to Front Range and Grand County communities.

Rocky Mountain National Park, like many national parks, offers ranger-led education programs. Heart of the Rockies, Rocky's education program, provides free field and classroom based education programs, aligned to Colorado education standards. School groups should make reservations at least 6 months in advance. National Park entrance fee waivers may also be available for school visits. For further information or to schedule a program please contact the Education Program Manager at (970) 586-1338.

A variety of ranger-led education programs are offered seasonally. Programs in the spring and fall are generally similar focusing on a variety of park topics; programs in the winter are limited to snowshoeing programs and classroom programs focusing on winter. To see a list of the latest available programs please visit http://www.nps.gov/romo/forteachers/planafieldtrip.htm.

# Fire Ecology
# Background Information

# Introduction

Fire plays an important role in many ecosystems. It is a natural, episodic event on the same level as other natural occurrences, such as tornadoes, earthquakes, and floods. For many ecosystems, fire is essential for succession, regeneration, and maintenance of healthy forests. Land managers now recognize the necessity of fire to maintain healthy ecosystems and consider fire a necessary tool in monitoring and managing native flora and fauna.

# Humans and Fire

Many indigenous cultures throughout North America learned to wield the power of fire in order to maintain, create, or protect valuable resources. Some tribes used fire to drive game animals into narrow chutes, lakes, and even off cliffs for easy hunting. Fire was also used as a means of protecting valuable resources by using it to clear undergrowth in forests and to maintain the ecotones along forest edges (the places most diverse in plant and animal life). Fire as a means of warfare, burning the land they wanted to protect from neighboring nations, and utilizing smoke as a means of communication over long distances, were also utilized.

This painting by Frederick Remington depicts the use of fire by native people to clear land for farming.


European settlers mainly used fire for ease of settlement and unification of the land. Slash-and-burn techniques became a common agricultural practice for clearing land and recycling nutrients. Along with European settlers came the mentality of using fire as a destructive force. It was considered a dangerous natural disaster that should be suppressed to protect homes and land. This philosophy of fire as a danger has been perpetuated in modernity by the cultural icon and nation-wide Forest Service campaign of Smokey the Bear and the classic Disney movie Bambi.

This approach of suppressing all fires was used by public land managers until the 1960s, when ecologists began to better understand the necessity of natural fire. Fire suppression had caused an increase in fuel severity and intensity, especially among plant communities that had historically experienced frequent low severity fires.

If you look closely, the landscape of RMNP has stories of two significant fires to tell: that of the Ouzel Fire of 1978 and the Fern Lake Fire of 2012. The Ouzel Fire was a lightning ignited fire in the Wild Basin area that lasted nearly two months. The strike occurred in the subalpine ecosystem, but in the early days of September high winds accelerated the fire moving it below the 10,000 foot elevation mark. With the aid of strong, westerly, downslope winds, the fire quickly made a jump and threatened the town of Allenspark. Nearly 600 people contributed to the fire suppression effort, using helicopters, bulldozers, chainsaws, hand tools, hand water pumps, and hoses to confine the fire within the park boundary. A total of 1,050 acres had burned by September 30, when the fire was finally contained.

Vegetation and trees regenerate after the Ouzel Fire.

In contrast, the Fern Lake Fire started from an illegal campfire on October 9, 2012, in steep and rugged Forest Canyon. Firefighters from across the country battled the fire for two months. There was limited opportunity to fight the fire directly because of high winds, steep terrain, and beetle-killed trees. On the night of November 30, and the early morning of December 1, strong winds pushed the fire more than three miles in thirty-five minutes, prompting evacuation orders for parts of the town of Estes Park. Through careful planning and rapid action, firefighters successfully prevented the fire from leaving the park. Largely inaccessible, Forest Canyon had been untouched by fire for at least 800 years. A long-term drought had left fuels tinder-dry in a dead and down fuel layer that in some areas exceeds twenty feet deep. Mountain pine beetles had killed half the trees in the canyon, with every compromised tree posing a hazard for firefighters. The typically windy conditions in the canyon only increased the danger. The nearly 3,500 acre blaze was temporarily halted by an early December snowstorm. This high-elevation winter fire was unprecedented in park history.

## Fire: A Chemical Reaction

**Fire's chemical reaction:**

Carbohydrate (fuel) + Oxygen + Heat

Carbon dioxide + Water Vapor + Heat + Light

Fire is a self-sustaining combustion reaction completed by the presence of fuel and oxygen when sufficient heat is present.
The ignition source is the pilot heat that initiates the reaction by heating fuels to a temperature where combustion can occur, sometimes on a very, very small scale. Once started, heat is spread to ignite other fuels which in turn create even more heat, igniting more fuel and enlarging the fire. Visually, there are two types of combustion in the forest: flaming and glowing/smoldering. Flames are visible during combustion with unlimited fuel and heat. The

reactions continue in the air above the fuel. Glowing/smoldering fires burn with little or no flame because heat and/or fuel is limited. Both processes continue until interrupted by a lack of fuel, oxygen and/or heat.

Heat is released as a result of the combustion reaction, which is a rapid release of energy trapped in the bonds of the molecules. Heat can spread or transfer via radiation, convection, conduction or advection, depending on conditions. These methods of heat transfer are integral to understanding the movement and behavior of fire.

**Radiation** is energy in outward motion from an identifiable source. When the wave comes in contact with an object it transfers the energy into it, subsequently heating the object. Radiation can be witnessed on a hot day in summer when the rays from the sun travel through space to warm the sidewalk.

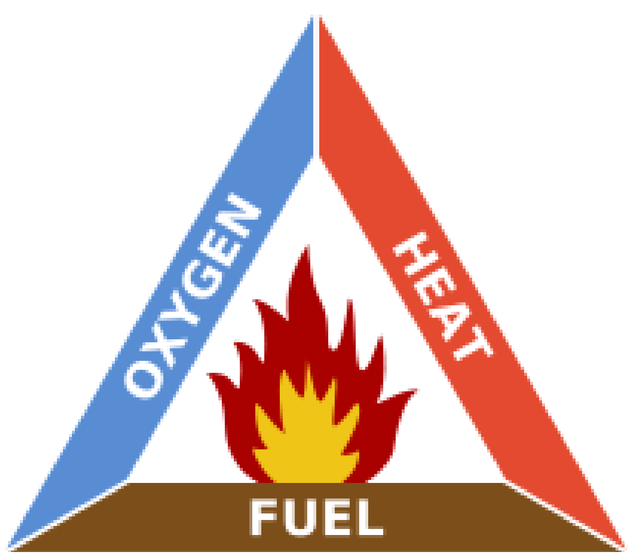
**Convection** is the rising of a gas or liquid. As a result of heat transfer, the gases and liquids rise as they heat because the matter is becoming less dense than the cooler matter around it. An example of convection is how water boils. The warm water in a pot will float to the top sending the cold water to the bottom.

**Advection** is very similar to convection, except the heat transfer is horizontal. This transfer can happen by wind and is an important factor in wildland fires.

**Conduction** is the transfer of heat from one substance to another when in direct contact. For example, when a pot is placed on a hot burner the pot warms, in turn heating the liquid inside.

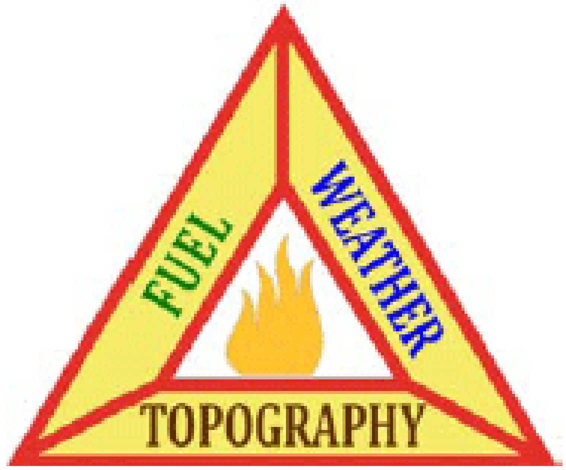
## The Fire Triangle

The three elements needed to sustain a fire are oxygen, heat (ignition source) and fuel which make up the three sides of the fire triangle. Take away one of these elements and the fire goes out (or doesn't start).



# Fire Behavior Triangle

Fire behavior refers to the rate of spread (in feet/hour) of a fire and its level of intensity in a forest. The amount and arrangement of fuels, the topography, and weather conditions are the critical components that make up the fire behavior triangle. A change in one or more of these factors during a fire can alter its behavior and type.




# Fuels

Any substance that will ignite and burn is considered a fuel. Areas that have high amounts of down and dried materials have increased fire potential. When it comes to dead fuels, fuel moisture is a function of atmospheric conditions and the surface area to volume ratio of the fuel. Weather influences the amount of available moisture and fuel particle size affects the rate at which moisture is either lost or gained from the environment. Standing grass and tree fuels are classified by size and shape, 1-hour fuels are 0-1/4 inch in diameter, 10-hour fuels are ¼-1 inch in diameter, 100-hour fuels are 1-3 inches in diameter, and 1000-hour fuels are 3-8 inches in diameter. The dead fuel timelag categories (1-hour, 10-hour, 100-hour, 1000-hour) relate to the time it takes for fuel of different diameters to gain or lose 63% of the difference between its initial moisture content and a new moisture content.

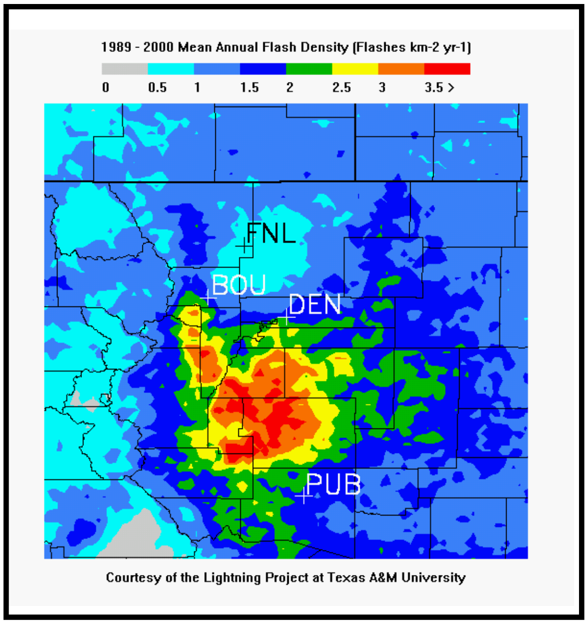
# Topography

The rough, rugged terrain of Forest Canyon is an example of extreme topography in RMNP.

Topography is the physical shape and features of a region. Terrain can greatly influence fire behavior. When fire starts at the bottom of a slope, the potential increases for fuels above the flames to become preheated and burn quickly. The opposite is true when the fire is started at the top: heat is rising, thus it will not preheat the vegetation lower on the slope.

Aspect will determine vegetation growth and amount of sunlight. A south and southwest facing slope will receive more sunlight and have dryer fuels. These conditions make it easy for fires to start and spread.

In a place like RMNP the remote, steep, and inaccessible terrain can make it extremely difficult to fight fires.




This map shows the frequency and density of lightning strikes in the Rocky Mountains.

# Weather Versus Climate

The peak for wildfire activity is typically during the summer months due to its characteristically hot, dry conditions and the afternoon thunderstorms which produce lightning. Most lightning strikes go from cloud to cloud, but 20% travel from cloud to ground. In 2012, the Rocky Mountain region had an astonishing 1,992 lightning fires that burned 850,596 acres. On average, RMNP experiences 3-7 lightning caused fires per year. At low humidity, fuels dry out, causing them to ignite easily and burn quickly. Winds, which are generated by the terrain and local differences in heating and cooling, can also increase the intensity of fire caused by heating differences especially in RMNP. Wind will blow upslope during the day and downslope at night. As the sun warms the slopes in the morning, the air above warms and rises while the cool air from the base of the slope moves up hill replacing it.

Climate looks at weather patterns and trends over a long period of time, whereas weather describes current temperature and precipitation conditions. A fire climate is the long-term weather pattern that determines fire weather and the length of the fire season. Climate change could lengthen and/or shift the time of year of the fire season as well as impact its intensity.

# Fire Classifications

**Ground Fire**

Ground fires burn natural matter in the soil beneath surface litter and are sustained by glowing combustion.

**Surface Fire**

The spread of fire with a flaming front and burned leaf litter, fallen branches and other fuels located at ground level make up a surface fire.

The fire crew monitors and contains a surface fire in a ponderosa pine stand in RMNP.

### Crown Fire

Crown fires spread from tree to tree above the ground. They are the most intense and need strong winds, relatively steep slopes, and/or heavy fuel load to continue burning. When crown fires become large and intense and spread quickly, they are renamed as conflagrations, which are large destructive fires with moving fronts and rapid rates of spread.

A crown fire during the Ouzel fire in Wild Basin.

"Fire has shaped vegetative communities for as long as vegetation and lightning have existed on earth."

-Stephen J. Pyne

Due to terrain and the presence of ladder fuels fire is carried from the ground to the trees as shown here.

### Ladder fuels

Ladder fuels are responsible for turning a surface fire into a crown fire by aiding fire in climbing tree limbs up to the canopy layer.

### Spot Fire

Spot fires occur when hot air rising from the fire carries embers and flaming pine cones upward and over to stands of trees ahead of the fire, where they start new fires.

### Convection Columns

This is a dense plume that is formed by convection, or the motion of hot air. When the column becomes large, so much warm air rises that it pulls the cool air around the fire into it, creating a noticeable indraft into the fire and giving birth to a veritable whirlwind of fire.

# Types of Forest Fires

**Wildland Fire**
Any non-structural fire that occurs in the wildland is considered a wildland fire and is categorized into one of two distinct types, wildfires and prescribed fires.

**Wildfire**
Wildfires are unplanned ignitions (regardless of ignition source), as well as planned ignitions that are declared wildfires.

**Prescribed Fire**
Prescribed fires are planned ignitions started by park managers. Prescribed fire, or a controlled burn, is very different from the other types of fire because it is planned. The plan is complex and must outline who is starting the fire, what resources are needed, number of acres burned, and what the weather, topography, and fuels are like. It also involves taking a holistic inventory of impacts, such as smoke considerations near schools or roads. The person(s) or agency who signs the plan is responsible for the fire and is held responsible if something happens that is not according to plan. Prescribed fires are often used to reduce fuels in an area in order to prevent a large wildfire, or for ecological issues in fire dependent ecosystems. For an example, in early September 2009, RMNP conducted a prescribed burn in Upper Beaver Meadows to help manage the area.

A lookout wildland fire fighter gives an update on the status of the Cow Creek Fire in RMNP.

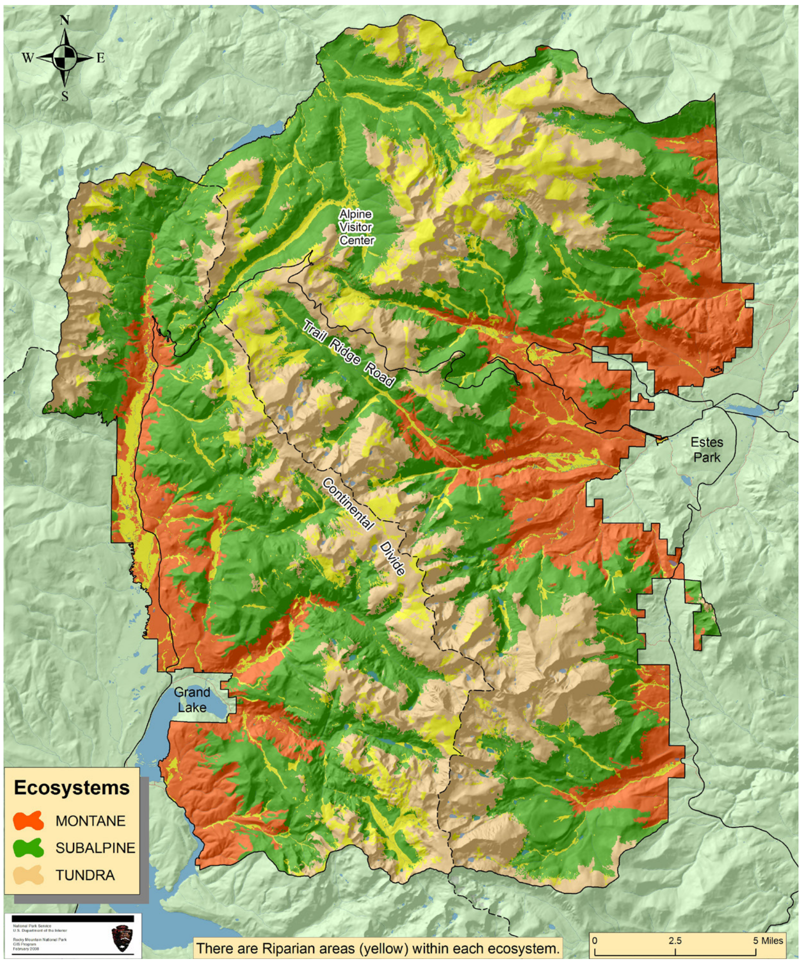
**Human Caused Wildfire**
A human triggered fire is usually caused by carelessness, such as an out of control campfire. In the park, the initial action on human caused wildfire is to suppress the fire at the lowest cost with the fewest negative consequences to firefighter and public safety; this applies to all federal agencies with wildland fire management responsibilities. Under the right conditions a wildfire could be managed for resource benefit, but an active role would still be taken with constant analysis of current and future potential kept in mind.

# Fire Ecology in Rocky Mountain National Park

Disturbance in an ecosystem results in a change of environmental conditions referring to both immediate and long-term effects on the natural community. Disturbances are often catalysts for the succession of an ecosystem. One of the most widespread disturbances in Colorado is fire. The current structure, species composition, and dynamics of many ecosystems in RMNP are often the direct result of past fires or are the result of other processes that have themselves been affected by fire. A fire regime refers to the pattern, frequency, and intensity of a fire.

# Ecosystems of Rocky Mountain National Park

**The Montane Ecosystem**
(Elevation Range: 7,500ft-9,500ft)
Montane Grasslands
Montane grasslands are characterized by low-intensity fires with a fire regime of 20-30 years. These fires will typically clear a high percentage of the vegetation, due to drier conditions and abundant fine fuels.




**The Subalpine Ecosystem**
(Elevation Range: 9,500ft-11,500ft)
Spruce-Fir Forests, Limber Pine Woodlands
The spruce-fir and limber pine woodlands dominate the sub-alpine in thick stands. The fire regime of these forests is characterized by very infrequent, high-intensity fires. In the rare event of a fire within a sub-alpine forest, either a single tree will burn, or an entire forest will be leveled. Due to cool and moist conditions the sub-alpine woodlands have extremely long intervals between fires, typically a century or more. There are spruce-fir stands in the Wild Basin area of RMNP that have not burned in over 400 years.

Mountain Sagebrush Shrublands
Mountain Sagebrush Shrubland ecosystem is characterized by high-intensity fires that eliminate a majority of the vegetation with a regime of 20-30 years.

Ponderosa Pine Forest
Ponderosa pine forests are characterized by a mixed severity fire regime which includes patches of both low intensity surface fires and high intensity crown fires. This variable severity results in a complex mosaic of species composition and stand ages across the landscape.

Lodgepole Pine Forest
Montane ecosystems on the west side of the park are dominated by lodgepole pines. Lodgepole forests tend to experience large, stand-replacing crown fires, often leading to a reestablishment of a new-generation (High-Intensity, Regime: 50-150+ years).

Mixed Conifer Forest
Mixed conifer forests, usually adjacent to the lodgepole or ponderosa pines, will typically experience low frequency, high-intensity fires and are found on more moist, north-facing slopes. This is because these stands rarely get dry enough to burn except under severe drought conditions.

**The Alpine Ecosystem**
(Elevation Range: 11,500ft +)
The alpine ecosystem of RMNP represents the highest elevation zone. Fires within this ecosystem are extremely rare and, subsequently, play a minimal role. The cool, moist conditions, along with minimal fuels, are not conducive for supporting fires. Fire may move into the alpine from adjacent subalpine forests, therefore the fire regime of the alpine is similar to that of the neighboring subalpine forests (greater than 300 years).

# Advantages and Disadvantages of Fire

**Advantages**

Frequent, periodic fires maintain hazards at low levels protecting against high intensity severe wildfires. When a wildfire clears an area, it creates a new open landscape for succession to begin again. These periodic fires create uneven-aged stands, comprised of even-aged groups of trees of various age classes. These open spaces allow for new growth, especially of pioneer species such as aspen, to sprout up.

These two photos show the landscape after the most recent fire in the park, Fern Lake Fire near the Cub Lake Trail Head.

Fire can benefit wildlife in many ways: readily available new growth can provide enhanced nutrition and changes to the landscape can provide new places to hide. In addition to taking advantage of new regrowth of vegetation, some wildlife may even eat charcoal and ashes because of its high mineral and carbon content. Coyotes, because of their generalist tendencies, can benefit from wildfire by easily moving in and out of the area. They will utilize cleared areas from the burn for spotting and chasing their prey, such as mice. Birds take advantage of new habitat resources by nesting in snags and cavities in trees and gain food resources from insects that are either turned up by the fire or that move in shortly after.

**Disadvantages**

While fire can remove invasive species, such as cheatgrass, from an area, the same species may quickly return due to the creation of new open space. Often fire can provide ideal conditions for the introduction and spread of invasive species. In RMNP, park managers work closely with exotic vegetation crews to follow up with intensive treatments for exotics in burn areas and planting native species.

Soil and water quality in the burn area can be heavily influenced by wildfire. The clearing of an entire area can leave soil exposed to direct sunlight causing it to dry out. This can have negative impacts on the species of decomposers. Dry, exposed soil is also susceptible to erosion and run off. Due to the ash that falls during a fire, the pH level of the soil can increase, making it harder for new plant species to colonize. Ash and particles in the air make riparian areas extremely susceptible to disturbance by wildfires. This can impact fish, macroinvertebrates, and other animals including humans that depend on water.  For example, boreal toads, which require permanent ponds or wetlands with adjoining willow thickets or shrub cover within about a mile and a half distance from each other often aren't able to survive disturbances from wildfire. Although wildlife habitat may eventually improve, most animals will have to leave the area during and after the event.

## Featured Plant and Animal Fire Adaptations

Plants and animals have developed both physical and behavioral adaptations to help them deal with the natural occurrence of fire.

Ponderosa Pine
Ponderosa pines are well adapted to survive low-intensity fires. Their thick bark and self-pruning growth, allows for protection from a surface fire moving up the trunk. They are able to grow new rings over injuries caused by fire, which dendrologists call fire scars. The seedlings grow quickly in the sun following a fire, due to less competition with small vegetation which may otherwise demand the available moisture.

Lodgepole Pine
Lodgepole pines can produce serotinous cones, which require heat to open and germinate, however they also produce cones that open when the seeds are mature, in the same way as other conifers. The ratio of serotinous to non-serotinous cones on a tree varies with stand composition and location. Lodgepoles have relatively thin bark but are able to survive most low-intensity surface fires. The seedlings grow quickly in the clearings where the duff has been scorched away. Lodgepoles may only live about 100 years before they begin to die, this is relatively young for a tree, and these trees rely on disturbance for re-establishment. Without fire, other types of shade-loving conifers would eventually dominate the lodgepole forests.

Serotinous cones on a lodgepole pine tree.

Douglas-fir
Douglas-firs are shade-tolerant trees that often grow slowly beneath faster growing, sun-loving species. Their branches grow close to the ground, acting as a ladder and allowing fire to spread up the trunk and often to the crowns of other trees. As a douglas-fir matures, thick bark helps to protect against surface fires. It does not possess the ability to re-sprout from its bulb and root structure, therefore regeneration from reseeding is its only form of restoration. It may take as long as a hundred years for Douglas-fir to reestablish itself after a stand destroying fire event.

### Aspen

Mature aspens usually contain more moisture than surrounding coniferous stands to the point where they often act as natural fuel breaks. Aspens are generally one of the first species to reappear, after any type of disturbance, making them a pioneer species. Fires help aspens sprout because they contain a growth enzyme which remains dormant until the heat of a fire destroys the chemical that keeps the enzyme inactive. Fire-killed stands promptly regrow by root sprouts, also called suckers.

### Fireweed

Fireweed, a flowering plant, is appropriately named due to its rapid colonization of recently burned or disturbed areas. It is a pioneer species and requires a lot of light and space to germinate. The seeds can lay dormant in the soil for many years, waiting for the right conditions to sprout. In some places the seed count is so high fireweed will cover almost the entire area of newly burnt land.

### Cheatgrass (Invasive)

Cheatgrass is a short grass species native to Europe, southwestern Asia, and northern Africa. Here in the United States, it is an invasive species that is specifically well adapted to thrive in areas of disturbance. Following a fire, cheatgrass is quick to move in and dominate the landscape, oftentimes destroying the habitat for native grasses and shrubs. Cheatgrass is highly flammable and can increase the frequency of fire. Some shrublands that have become colonized by cheatgrass show a significant increase in the incidence of fires, from a fire every 5-25 years down to every 3-5 years.

### Musk Thistle (Invasive)

Another abundant invasive species that is found throughout RMNP and the United States. Although fire seems to be a destructive force, low-intensity fires do not provide any means of combating this plant. If the fire doesn't reach a high enough temperature, the seed heads are often unaffected and the root crown will remain undamaged, allowing the plant to sprout anew.

### Elk

Elk migrate between different ecosystems in RMNP, spending time in the alpine during the summer and the montane during the winter. Fires which spread through a stand create a habitat for elk to seek shelter and find food.

### Badgers

Badgers and other burrowing animals are rarely threatened by wildfires. Although badgers live in the montane where fire is a natural occurrence in the ecosystem, there are rarely mortalities because badgers tend to stay underground during the day, when fires reach their peak temperatures. They can dig deeper underground when threatened and often have multiple entrances to their burrow, making asphyxiation unlikely. However, they may leave an area following a fire, due to a decrease in available food.

### Woodpeckers

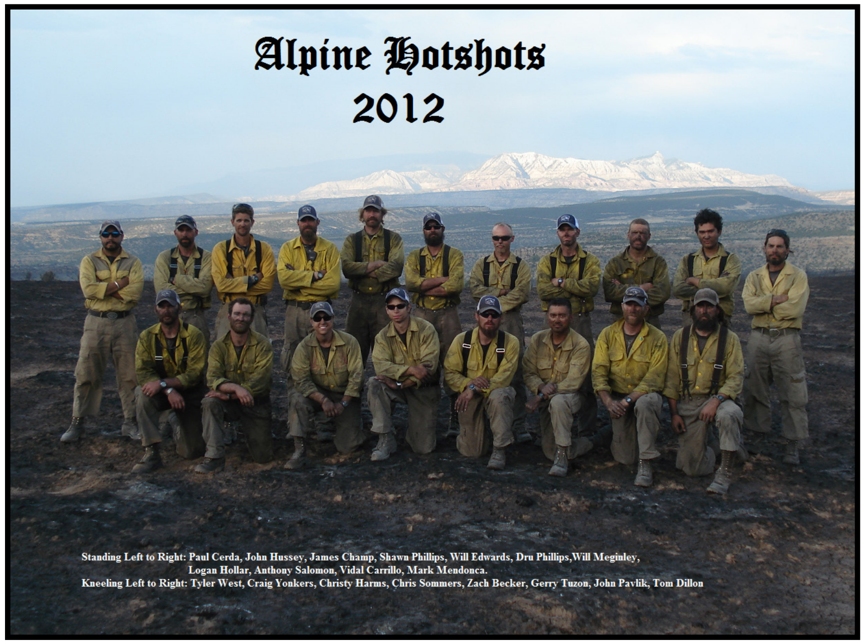
Frequent surface fires, such as those often exhibited in areas of ponderosa pine forests, help to maintain older trees by eliminating competition from younger trees. Older trees are more likely to experience rot or canker fungus. Standing trees with rot provide excellent nesting cavities for woodpeckers and completely fallen trees provide food. Woodpecker populations often increase following high severity wildfire, capitalizing on the insects that infest the fire-killed trees.

# Fire Management at Rocky Mountain National Park

The department of Fire Management at RMNP recently created a set of guidelines to help direct the park in making decisions concerning preemptive management and management in response to wildfires. These guidelines are specific to RMNP and are mindful of the cultural and natural resources that are unique to the park. The following excerpts highlight the mission of Wildland Fire Management within the park and the framework for decision making. These statements are taken directly from the Rocky Mountain National Park 2012 Wildland Fire Management Plan.

**Fire Management Mission Statement**

Rocky Mountain National Park's fire management program will protect employees and the public, communities and infrastructure, conserve natural and cultural resources and restore and maintain ecological health.




There are two main program elements that focus all activities on achieving the Mission:

1.Fuels Management

Proactive planned activities such as prescribed fire, manual and mechanical thinning of forest vegetation with the objective of reducing hazardous fuels around local communities and infrastructure, restoring fire adapted landscapes, and other protection and resource management objectives.

2. Response to Wildfires

Decisions and actions implemented to manage a wildfire based on ecological, social, and legal consequences, the circumstances under which a fire occurs, and the likely consequences on firefighter and public safety and welfare, natural and cultural resources and values to be protected.

The Fire Decision Framework is the foundation for all planning in Fuels Management and the Response to Wildfires. All projects and response plans are designed based upon improving the ability to achieve the elements within the Framework.

Fire Decision Framework:

1. Provide for the safety of employees and the public.
2. Protection of communities, infrastructure, and natural and cultural resources.
3. Restore and maintain fire-adapted ecosystems.

# Fire and the Mountain Pine Bark Beetle

The Mountain Pine Bark Beetle (MPBB) is a native bark beetle species targeting pine trees in RMNP by burrowing into the bark and eating the inner cambium layer. Three species of trees are at risk in RMNP: the ponderosa pine, lodgepole pine, and limber pine. The beetles live about 245 days and will infest one tree during their lifecycle. The females initiate the attack on a tree by sending out pheromones to attract males to the host tree.

To help fight back, the infested tree will send pitch through the tunnels and holes created by beetles in an attempt to "pitch them out." These structures can be seen on the outside of an infested tree and are called pitch tubes. Trees that are well hydrated and free of damage and disease will be able to put out more pitch for protection.

Pine Bark Beetle pitch tube.

Blue Stain Fungus works in symbiosis with the beetles, carried on their bodies to new trees. Once the fungus is in the tree, it spreads through the transport systems of the tree, effectively dehydrating and choking the tree; the two working together will most often kill a tree.

A student conducts research to learn more about pine bark beetles during an education program at RMNP.

Much of the research on the effects of MPBB and their relationship to fire is ongoing. Some models suggest fire activity could increase if there were to be a fire immediately after the trees in an area have been killed by beetles. Dry branches and needles on trees affected by MPBB provide ample fuel and allow the fire to climb, possibly starting a high-intensity crown fire. It is believed after the needles have fallen off; fire activity could be lower than that of a fire in a live stand. Beyond this, MPBB-attacked trees pose a major hazard for firefighters because the trees are prone to fall over in a wildland fire event.

Wildfires have been shown to reduce the amount of MPBB attacks over time. MPBB are attracted to trees that have been damaged by fire because they are weaker. These trees provide an opportunity for easy infestation. The surviving trees will then grow vigorously due to a greater availability of resources, and will be better equipped to fend off an eventual attack by MPBB.

Burn piles in RMNP

Hazardous trees in RMNP are those dead or dying trees in high use areas, such as roadways or picnic areas. A major cause for these piles is from the high MPBB population. Fire managers within RMNP inventory hazardous trees and remove them when necessary. Removed trees are placed in teepee-looking structures, called burn piles, where they are left to dry out. At least six inches of snow and appropriate weather conditions are necessary before burning.

In contrast, trees that contain live beetles are disposed of in the park's air curtain burner. This machine results in full mortality of beetle larvae which assists resource managers in reducing the population of adult beetles.

During winter months fire crews burn piles of cut down hazard trees when there is enough snow and low winds.

# Fire Ecology Resources

# Classroom Book List

These books are not endorsed by the National Park Service. They are intended to serve as classroom resources for students. Please be sure to preview books to ensure that they are appropriate for your classroom. This list is by no means inclusive of every book available on the topic.

Elementary Level Books

Wildfires by Seymour Simon

Wildfires by Matt Doeden

Fire in Their Eyes: Wildfires and the People Who Flight Them by Karen Magnuson Beil

Wildfire Alert! By Lynn Peppas

Wildfire! By Elizabeth Starr Hill

Blaze and the Forest Fire: Billy and Blaze Spread the Alarm by C.W. Anderson

Big Frank's Fire Truck by Leslie McGuire

High School Level Books

The Book of Fire by William H. Cottrell Jr.

Wildfire: A Reader by Alianor True

Forest Fires: An Introduction to Wildland Fire Behavior, Management, Firefighting, and Prevention by Margaret Fuller

A Season of Fire: Four Months on the Firelines of America's Forests by Douglas Gantenbein

Fire on the Mountain: The True Story of the South Canyon Fire by John N. Maclean

Fire and Ashes: On the Front Lines Battling Wildfires by John N. Maclean

Hotshot: A Veteran's Personal Look at the Forest Service's Elite Team of Firefighters by John Buckley

Making the Bear Dance: A Naturalist's Journey into the World of Wildland Firefighting by Jeff Connor

Media

Fire and Wildlife: The Habitat Connection by Stoney Wolf Video Productions

Two Sides of Fire by Temperate Forest Foundation

Burning Issues: An Interactive Multimedia Program Including Simulated Exercise and Educator's Guide by the Interactive Media Science Project

Fire Wars by NOVA

National Interagency Fire Center Website- www.nifc.gov

For current fire information in RMNP please visit- http://www.nps.gov/romo/naturescience/currentfires.htm

# Glossary

**Advection**- Similar to convection, except that the heat transfer is horizontal instead of vertical.

**Aspect**- The degree in which a slope sits.

**Combustion**- Consumption of fuels by oxidation producing heat.

**Conduction**- Transfer of heat from one substance to another when they are in direct contact with one another.

**Cone**- Where conifer stores its seeds; reproductive structure of a conifer.

**Conflagrations**- Large destructive fires with moving fronts and rapid rates of spread.

**Conifer**-Any gymnosperm tree or shrub of the phylum Coniferophyta typically bearing cones and evergreen leave. The group includes pines, spruces, firs, larches, yews, junipers, cedars, cypresses, and sequoias.

**Controlled Burn**-Fire started and monitored by managers to reduce hazardous fuels in an area.

**Convection**- The rising of gases or liquids as a result of heat transfer; the gases and liquids rise as they heat because the matter is becoming less dense than the cooler matter around it.

**Crown Fire**-A fire that spreads from the top of one tree to another.

**Deciduous**- A kind of plant that is able to shed its leaves in the fall or when it becomes very dry.

**Decomposition**- The physical breakdown of organic and inorganic material.

**Duff**- Materials on the forest floor that are fuels in various stages of decomposition.

**Ecotone**- The transition between two biological communities.

**Fire Climate**-The long-term weather pattern that determines the fire weather and the length of the fire season.

**Fire Ecology**-The study of the links between the natural instance of fire in an ecosystem and its ecological effects.

**Fire Management**- Actions to prevent wildland fires, suppress them, or manage them for particular purposes, like improvement of wildlife habitat.

**Fire Regime**- Frequency and intensity of fires within a specific ecosystem over a certain amount of time.

**Fire Scar**-A healed over injury caused by a fire in a woody plant.

**Fire storm**-A large area of intense heat that causes violent convection.

**Fire Triangle**- An instructional aid in which the sides represent the three factors (oxygen, heat, and fuel) need for combustion.

**Fire Whirl**- A spinning, moving column of air that carries flames, smoke, and debris aloft and forms a vortex.

**Flame**- A mass of gas undergoing rapid combustion.

**Fuel**- Any combustible material.

**Ground Fire**- Fire that burns the duff and mineral soil layers.

**Hazardous Tree**- Include dead or dying trees or any part that are within striking distance of people or property.

**Invasive Species**- A species not native to a specific place.

**Ladder Fuels**- Fuels that provide vertical movement from forest floor to canopy.

**Pioneer Species**-A species colonizing previously uncolonized piece of land.

**Pitch Tube**- A tubular mass of resin that a tree will use to try and push a pine bark beetle out.

**Prescribed fire**- A wildland fire ignited by managers to meet particular goals.

**Pyrolysis**- The decomposition of fuels at elevated temperatures.

**Radiation**- Heat in a wave or ray, when the wave comes in contact with an object it transfers the energy into that object, subsequently heating it.

**Sapling**- A young tree.

**Scorch**- Permanent discoloration of plant parts caused by heating.

**Serotinous**-A property of tree cones, in which their scales are sealed by resin and they cannot release seeds until the resin in melted by heat.

**Slope**- The steepness of a land area.

**Snag**- A standing dead tree or a portion of one.

**Soot**- Carbon from the incomplete combustion of wood.

**Spot fire**- Fire that jumps outside the perimeter of the main fire.

**Succession**- The order in which plants return to an area after a fire or other disturbance.

**Surface fire**- Fire in the litter, duff, grasses, and wildflowers on the forest floor but does not burn in the crowns of trees.

**Tar**-Droplets of pyrolyzed fuels that have not burned completely.

**Wildland**- An area in which development is nonexistent.

**Wildland Fire**- Any fire occurring in wildland except a prescribed burn.

# References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