Fact Sheet: Understanding Fire and Fire Behavior

Fire always obeys the laws of physics, and is always made up of three elements: fuel, oxygen, and heat. How it behaves on the landscape can be unpredictable. Yet people can, to an extent, shape how fire moves through a landscape, even one as large as southwestern ponderosa pine forests.

Wildland Fire Basics

- **Fire comes in different forms:** it can smolder on the ground for days or race through tree crowns in minutes.[1] Ground fires that burn mainly grasses and downed pine needles are considered typical for healthy ponderosa pine forests in the Southwest. Today, however, many fires in the region are crown fires that consume entire trees and pose a danger to human lives and communities.[2]

Types of Fire
Surface fire (left)
Ground fire (burns below the surface)
Crown fire (right: burns tree canopies)

Flaming Zone

Smoldering Combustion

- **Fire behavior changes with the fire's environment.** Topography, weather, fuel, and the fire itself all influence fire behavior. As these variables interact, fire behavior will change.

- **Fire spreads most rapidly downwind and upslope.** The fastest-spreading part of the perimeter is called the ***front*** or ***head***; the slowest-spreading part is called the ***back***. The lateral portions, or ***flanks***, spread at intermediate rates. Fires n the Southwest often move from southwest to northeast due to the prevailing winds during fire season in May and June.

- **Fire doesn't spread only along its edge.** In general, fire grows by igniting new fuel along its outer perimeter. However, it may spread more rapidly by producing embers or sparks that are carried by wind and the fire's convection column. The 1967 Sundance Fire traveled 16 miles in 9 hours, created "spot fires" 10 to 12 miles from the place of origin, and overall moved at an average rate of 1 to 6 miles per hour.

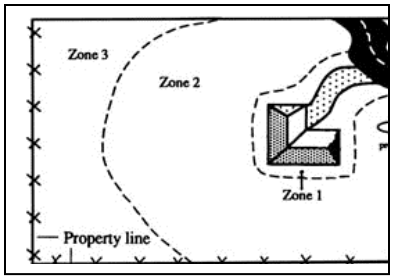
- **Fire can create its own environment.** Heating from the fire can produce local winds, create atmospheric instability, and cause cumulus clouds to develop. In an extreme state, a "plume-dominated fire" (e.g., the Rodeo-Chediski Fire, below right) can create a combustion cloud that produces lightning, rain, and dangerous downbursts of winds up to 60 mph, sending embers in all directions.

- **Southwestern uplands are highly flammable.** In late spring and early summer dry conditions, high winds, and heavy fuel accumulations combine with lightning and human-induced fire starts to create ideal conditions for large, severe fires in many southwestern ponderosa pine forests.

Home Protection and the Wildland –Urban Interface (WUI)

- **Buildings ignite when wildland fire comes within a few feet of flammable building materials.**[3] Houses most often burn when grass, wood piles, wood chips, and other fuels in the yard catch fire, but wind-borne embers can also ignite buildings that are much farther from the fire front.

- **Homeowners can minimize fire risk by reducing hazardous fuels around and adjacent to their homes to create "defensible space."** In addition, minimizing the use of highly flammable building materials (such as wood roofs and siding) can reduce the threat posed by wind-borne embers. These simple steps can allow homes to survive even some extremely severe wildfires.[4]



Creating defensible space involves developing a series of management zones in which different treatments are used.[5]

- **Fuel breaks can be efficient and cost effective in protecting communities from catastrophic wildfire.** However, they are not a replacement for a strategic fuels treatment program because they address neither homeowner responsibilities for fire-safe yards and houses nor the need to restore southwestern ponderosa pine forests on a landscape scale.[6] They also can be overwhelmed by wind-driven fires that produce embers and spot fires.

- **Community protection plans must incorporate landscape considerations.** Such factors as topography, prevailing winds, and fuel patterns can allow fire to travel extremely quickly. Fire protection plans for towns, subdivisions, and neighborhoods must consider such factors to be effective.

- **Buildings and other structures are not the only values at risk.** Many southwestern communities rely on surrounding forests for tourism, recreation, aesthetics, resource extraction, watershed protection, and other values. Protecting only developed areas, and not

forests, raises the possibility that fire-safe towns will be set in a landscape of burned forests and degraded ecological values for many decades to come.

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[1]Pyne, S.J., P. Andrews and R.D. Laven. 1996. "Introduction to Wildland Fire, 2nd Edition." John Wiley & Sons, pp 46-87.
[2] Betancourt, J.L., T.W. Swetnam, C.D. Allen and M. Savage. 2003. "Fire in the West: It's No Simple Story." High Country News, July 7, 2003. www.hcn.org/servlets/hcn.Article?article_id=14110.
[3] Cohen, J. 2003. "An Examination of the Summerhaven, Arizona Home Destruction Related to the Local Wildland Fire Behavior during the June 2003 Aspen Fire." Unpublished Report/USDA Forest Service/Rocky Mountain Research Station/Missoula Fire Sciences Laboratory.
[4] University of Arizona Cooperative Extension. 2002. "Creating Wildfire-Defensible Spaces for Your Home and Property." Publication AZ1290. ag.Arizona.edu/pubs/natresources/az1290.pdf.
[5] Cooperative Extension, College of Agriculture and Life Sciences, University of Arizona. 2003. "Creating Wildfire-Defensible Space for your Home and Property". http://www.cals.arizona.edu/pubs/natresources/az1290/
[6] Graham, Russell T. 2003. "Influence of Forest Structure on Wildfire Behavior and the Severity of Its Effects: An Overview." U.S. Forest Service, North Central Experiment Station.