

Fuels Planning: Science Synthesis and Integration

Fact Sheet # 41

Fire Hazard

Synthesizing Forest Structure and Fire Hazard Information for Project Managers

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December 2003



USDA Forest Service - Rocky Mountain Region Archives, USDA Forest Service, www.forestryimages.org

Fire Hazard

Fire hazard reflects the potential fire behavior and magnitude of effects as a function of fuel conditions. Understanding the structure of fuelbeds and their role in the initiation and propagation of fire is key to developing effective fuel management strategies.

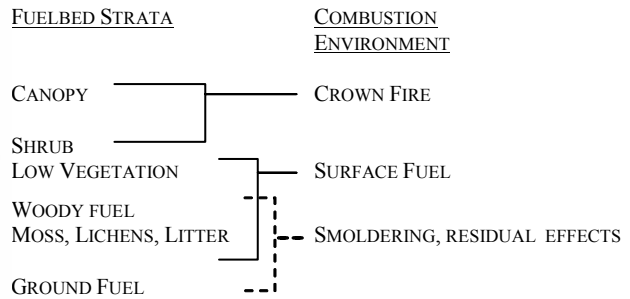
Fuels have been traditionally characterized as crown fuels

(live and dead material in the canopy of trees), surface fuels (grass, shrubs, litter, and wood in contact with the ground surface), and ground fuels (organic soil horizons, or duff, and buried wood). A more refined classification separates fuelbeds into six strata, or layers: tree canopy; shrubs/small trees; low vegetation; woody fuels; moss, lichens, and litter; and ground fuels (duff). Modification of any fuel stratum has implications for fire behavior, fire suppression, and fire effects.

The tree canopy is the primary stratum involved in independent crown fires, and the spatial continuity and density of tree canopies combine with fuel moisture and wind to determine rate of fire spread and severity. The shrub/small tree stratum is also involved in crown fires by increasing surface fireline intensity and serving as "ladder fuels" that provide continuity from the surface fuels to canopy fuels, thereby potentially facilitating active crown fires.

Three fuelbed strata contribute to the initiation and spread of surface fires. Low vegetation, consisting of grasses and herbs, can carry surface fires when that vegetation is dead or has low moisture content. Woody fuel is sound logs, rotten logs, stumps, and wood piles from either natural causes or management activities. Wood can greatly increase energy release from surface fires and can in some cases increase flame lengths sufficiently to ignite ladder fuels and canopy fuels. Moss, lichens, and litter on the forest floor can also increase energy release in surface fuels. Because of the potential for surface fires to propagate into crown fires – even if tree density and crowns have been greatly reduced – treatment of surface fuels must be considered when planning treatments for ladder fuels and crown fuels.

Three fuelbed strata contribute to the initiation and slow spread of smoldering fires. Ground fuel, primarily soil organic horizons (or duff), contributes most of the fuel, and can burn slowly for days to months. Moss, lichens, and litter have



high surface area and when very dry can facilitate both the spread of smoldering fires and facilitate a transition to surface (flaming) fire. Woody fuels (sound logs, rotten logs, stumps, and wood piles) are often underestimated as a component of smoldering fire, but can sustain low intensity burning for weeks to months, with potential flaming combustion under dry, windy conditions. Combustion of woody fuel also can contribute significantly to smoke production and soil impacts (e.g., loss of organic matter, erosion).

Quantifying Fire Hazard and Fire Potential

Accurate quantification of fuels in the canopy and shrub/small tree strata is necessary to understand the combustion environment of crown fire. The most effective techniques for reducing crown fire occurrence and severity have been:

- Increasing canopy base height.
- Reducing canopy bulk density.
- Reducing forest canopy continuity.
- Reducing surface fuels.

Objective and quantifiable fuel-treatment criteria will assist fire managers and silviculturists in achieving desired conditions for canopy base height, canopy bulk density, and canopy continuity.

To avoid torching and crown fire initiation, canopy base height (the average height from the ground to the lowest living foliage) may need to be considerably higher than the height of expected flame lengths for a specified fuelbed. For most dry forests, this value will be greater than 20 feet (6 meters). Target values of canopy base height can be inferred from canopy fuel descriptions for various forest types.

To keep an active crown fire from being sustainable, Canopy bulk density – the foliage (mass of available fuel) contained per unit crown volume (kg m^{-3}) of a forest stand – may

need to be maintained below a critical threshold (a function of fire weather and fire rate of spread). This threshold is not well defined, the required reduction in stem density and basal area will vary between stands, depending on initial stem density and canopy structure. Target values of canopy bulk density can be inferred from canopy fuel descriptions for various forest types.

Canopy continuity—the physical contact of tree canopies—is a subjective fuel treatment target and is often difficult to quantify. If the objective is to reduce physical contact of tree canopies, an example of a field-based rule is that the distance between adjacent tree crowns should be half the average diameter of the crown of co-dominant trees in the stand.

Other Forest Structure and Fire Hazard Fact Sheets

Look for other fact sheet topics from the forest structure and fire hazard team with information about fire hazard, visualization, silviculture, uncertainty, and larger-scale treatments.

Fuels Planning: Synthesis & Integration

This fact sheet is one in a series being produced as part of a larger project supported by the USDA Forest Service to synthesize new knowledge and information relevant to fire and fuels management. Fact sheets address topics related to stand structure, environmental impacts, economics, and human responses to these factors. Information in the fact sheets is targeted for the dry forests of the inland West, but is often applicable across broad regions of the country. For more information, please visit our website at:

www.fs.fed.us/fire/tech_transfer/synthesis/synthesis_index

Although all of the Fuels Planning fact sheets have been reviewed by scientists, they are not official Forest Service publications and much of the work is based on preliminary findings. Information from fact sheets will be synthesized in an upcoming publication.