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Fuels Planning: Science Synthesis and Integration

Environmental Consequences Fact Sheet: 5

Prescriptions and Fire Effects



Pacific Northwest
Research Station



North Central
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Synthesizing Scientific Information for Fire and Fuels Project Managers

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Fuels planning: Science synthesis and integration, an interagency research/management partnership to support the Ten-Year Fire Plan, led by Russell T. Graham, RMRS, and Sarah M. McCaffrey, NCRS.



The amount of combustion of large woody fuels and duff layers after the flaming front has passed determines long-term heating (photo credit: Melanie Miller).

While our understanding of the causes for variation in postfire effects is increasing, burn prescriptions may not always include parameters that control the long-term heat pulse from fire. Prescribed fire prescriptions typically focus on elements associated with rate of spread and flame length because they relate to controlling fire intensity and keeping the fire within the burn unit. However, a given set of flame lengths and spread rates could result in a wide range of direct fire effects, including variations in plant mortality, smoke production, soil heating, and soil nutrient status change. These effects vary because of differences in fuel consumption, which

depends on the amount, size, arrangement, and compactness of woody fuel and duff layers, and their moisture content. Subsurface heating, for example, is largely controlled by large woody fuel and duff consumption that occurs in smoldering combustion, the amount of which may not be related to surface fire behavior.

Fuel Consumption and Fire Effects

Slowly burning woody fuels and duff can girdle tree cambium and kill tree roots. Duff consumption controls bare mineral soil seedbed creation; many species, especially conifers and weeds, require this bare mineral soil to establish seedlings. Subsurface heating determines resprouting potential or mortality of understory plants' roots and rhizomes, germination or death of buried seeds, and changes in soil nutrient chemistry.

Direct effects can interact and affect long-term outcomes. For example, berry crop quantity on resprouting shrubs is a function of healthy new stem and leaf tissue production, postfire soil nutrient availability, and increased light levels caused by canopy mortality.

The rate and amount of understory vegetation recovery and residual woody debris and duff quantity are important regulators of the number of years a site is susceptible to erosion from intense rainstorms or rapid snowmelt.

Prescription Design Considerations

Prescription designers determine optimal fine fuel moisture and weather elements to maximize control of rate of spread and flame length during a given prescribed fire. Additional fuel moisture parameters could be used to estimate large woody fuel and duff consumption, although choice of season is often the prescriptive element selected to minimize long-term heating. Most years, burning soon after snowmelt results in a low severity fire because large fuels cannot ignite or burn superficially, and wet soil cannot conduct much heat to deeper soil layers. Under these conditions, only the surface burns, and surface fire behavior, determine fire effects. Spring fires may not stimulate seeds, so a heat treatment or inducement of sufficient rhizomatous shrub resprouting and mineral soil seedbed creation may be required. Prescribed fires are also staged in autumn, after some rain has fallen and temperatures and relative humidity have moderated hot, dry summer conditions. Although autumn rains might sufficiently dampen fine fuels and moderate

surface fire behavior, they may not significantly increase moisture content of large woody fuels, duff layers, and soil. Such fires can be easy to control and cause limited crown scorch and canopy consumption. However, woody debris and duff layers may be sufficiently dry that once ignited, they can burn and smolder for weeks until significant fall rains finally make them too wet to burn. Severe fire effects could result, including girdling of trees, shrub root mortality, significant duff consumption, and lingering smoke.

Planning a Prescribed Fire

Prescribed fire planners should consider how much fuel is present in each fuel class, how much fuel the treatment might create, and what fuels might burn in a prescribed fire or wildfire. Questions to consider include:

- Can the fuelbed support flames long enough to significantly scorch the canopy, even though the trees won't crown?
- Will the treatment leave so much fuel that the site can only be burned under extremely moist conditions,



The burnout of adjacent accumulations of fuel can cause the death of a tree's cambium layer (photo credit: Melanie Miller).



Prescribed burns in late summer and fall may lead to severe effects because woody debris and duff layers may be dry enough to burn on their own, once ignited (photo credit: Bobbie Bartlette).

resulting in inadequate fuel consumption or not creating other desired effects?

- Is there enough sound, and especially rotten, coarse woody debris to result in significant smoldering?
- Are litter and duff layers thick enough to promote long-term combustion?
- Are there deep duff mounds around old trees?

The best fire prescriptions contain elements to regulate combustion of key fuels, both those that affect surface fire behavior and those that can burn in long duration, smoldering fire. Ambient weather and fine fuel conditions control fire spread and intensity. The factors most closely related to residual fuel consumption are the moisture content of large diameter woody fuels, and duff layers deeper than an inch. If potential exists for long duration fire, then soil moisture is also an important prescriptive element.

Fortunately, fuel consumption estimates are not difficult to acquire. The First Order Fire Effects Model (see fact sheet RMRS-RN-23-2-WWW) estimates fuel consumption at different moisture levels. The model can assist managers in developing and refining burn prescriptions. Monitoring moisture content and consumption of key fuel elements during prescribed fires provides a basis for adaptively adjusting prescriptions, promoting successful treatment replication.

Environmental Consequences Fact Sheets

Look for fact sheet topics from the Environmental Consequences Team including information about the effects of fire behavior and alternative treatment strategies, Wildlife Response Model, weed responses, riparian systems, soil erosion, restoration objectives, treated spaces, the Fire Effects Information System (FEIS), and the First Order Fire Effects Model (FOFEM).

Fuels Planning: Synthesis and 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 Web site at: www.fs.fed.us/fire/tech_transfer/synthesis/synthesis_index

The Fuels Planning fact sheets are based on preliminary findings. Information from fact sheets will be synthesized in an upcoming publication.