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Fire Influences on Coarse Woody Debris

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Fire influences coarse woody debris by removing and adding mass, transforming its form (e.g., charcoal formation), and altering post-fire decomposition rates. Numerous simple statements have been made about the impact of fire on coarse woody debris, but most apply to very specific situations. This is because the influence of fire upon coarse woody debris depends upon the interaction of macroclimate, weather preceding and during the fire, microclimate, decay state and position of pieces, and fire severity. A simple conceptual model is presented that generates the complex interactions occurring in a wide range of systems.

The primary influence of fire on coarse woody debris is usually considered to be removal. However, in most natural fires the major effect of fire is to add coarse woody debris rather than to remove it. Except for mild surface fires which kill few trees, the amount of coarse woody debris burned by fire is more than offset by the mass of trees killed. In fact, the highest levels of coarse woody debris in natural stands typically occur immediately after fire. In contrast, broadcast burning following timber harvest generally removes coarse woody debris.

Compared to fine fuels, coarse woody debris is very resistant to burning even under the most extreme fire weather conditions. This is caused by low surface to volume ratio and extremely slow drying rates of coarse woody debris. In pieces with advanced decay, the low surface to volume ratio is offset somewhat by the presence of cracks and fractures which may increase the effective surface to volume ratio. This, in turn, is counterbalanced by the ability of advanced decay material to store and retain moisture. This suggests that advanced decay stages (i.e., classes 4 and 5) will only burn after considerable drought, whereas sound pieces (i.e., classes 1-3) will only burn if adjacent to other pieces which reflect radiation.

It is generally thought that fire reduces decomposition rates. The degree fire alters the decomposition of coarse woody debris, however, is quite complex and depends upon an interaction of fire severity, climate, decay class and position of the piece. Fire killed trees are typically added to the detrital system as snags, but the degree this speeds or slows decomposition depends upon the macroclimate. Regardless of forest type, snags tend to be drier than logs, but the degree this coincides with the optimum moisture content varies with macroclimate. In moist forest regions (e.g., westside Douglas-fir) where excess moisture limits wood decay, the addition of snags will speed the overall decomposition of coarse woody debris in these forests. In dry forest regions (i.e., eastside ponderosa pine), where excessive drying limits decomposition, the addition of snags will reduce the overall decay rate.

Removal of the canopy and exterior charring both alter the microclimate of coarse woody debris, but this may increase or decrease decomposition rates depending upon the pre-fire microclimate. In cold or wet forest regions, removal of the canopy or charring should increase decomposition rates. In hot or dry forest regions, canopy removal or

charring may reduce decomposition rates as the frequency and duration of extreme temperatures or excessively dry conditions may increase.

The degree burning alters decomposition rates subsequent to the fire depends largely upon the interaction between decay class and fire severity. As fire severity increases, the decomposition rate should decrease in proportion to the amount of charcoal formed. In addition, as fire severity increases, the volume of decaying wood and bark removed should increase. This would reduce future decomposition by decreasing the potential of decomposer communities to spread into adjacent, undecayed tissues. This conceptual model suggests that certain decay classes are more susceptible than others to fire induced changes. Freshly killed trees should decompose at rates similar to snags killed by other causes, unless bark and sapwood are removed. Decomposition rates of class 1 to 2 logs and snags may be similar to those before the fire because the internal decomposer community is largely unaffected and may spread into adjacent undecayed tissues. Extremely decomposed pieces (i.e., class 4 and 5) may not be greatly affected even though decayed wood is very flammable compared to sound wood. This is because the decomposer community has spread throughout these pieces and only complete consumption will remove decomposers. Intermediate stages of decay (i.e., class 3) may be most susceptible, as decomposers have not spread throughout the piece, yet the partially decomposed sapwood and bark are easily removed by fire. Therefore, burning class 3 pieces may result in arrested decomposition if most of the decayed material is removed by fire.