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Effects of Post-fire Salvage Logging on Soil Water Repellency

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Post-fire soil water repellency (SWR) is often cited as a key cause of the large increases in surface runoff and erosion after high-severity fires. Post-fire salvage logging is an important management option, but little is known about how logging or other types of site disturbance affect SWR, infiltration, and sediment yields. The objectives of this paper are to: (1) determine how two different types of logging tracks affect SWR; (2) compare results from two techniques for assessing SWR; and (3) assess how the changes in SWR due to salvage logging affect infiltration and sediment yields. The primary study site was the 14,000 ha Red Eagle Fire in northern Montana USA, which burned a dense mixed coniferous forest in September 2006 and was partially logged in early summer 2007. Precipitation falls mostly as snow with some occasional summer rainstorms, so data were collected from summer 2007 through summer 2009.

The basic study design compared data from burned control sites to lightly-traveled feller-buncher tracks, more heavily-trafficked skid tracks, and logged convergent hillslopes ("swales"). SWR was measured at 2-cm intervals using the water drop penetration time (WDPT) and critical surface tension (CST), but both methods were not necessarily used at all sites for each year. Compaction was measured with a pocket penetrometer in 2007 and 2009, and infiltration was assessed using the mini-disk tension infiltrometer (MDI). Sediment yields were measured with sediment fences.

In 2007 there was significantly less SWR in the logging tracks than the adjacent points outside the tracks. SWR was slightly stronger in 2008, presumably due to drier soil conditions. SWR significantly decreased from 2008 to 2009 in the more heavily trafficked skid tracks, and in 2009 the skid tracks were again less repellent than the areas adjacent to the tracks and the control plots. SWR also was lower in the logged than the unlogged swales. These results indicate that the disturbance due to logging generally decreased SWR, particularly in the more trafficked areas, but the high variability made it difficult to detect significant differences, particularly for the WDPT.

Both types of logging tracks were significantly more compacted than the adjacent areas, and this compaction was stronger and more persistent in the skid tracks than the feller-buncher tracks. Infiltration significantly increased over time outside of the tracked areas but not in the tracks. There were no significant differences in infiltration between the tracked and untracked areas within years, possibly because the compaction in the tracks compensated for the reduction in SWR. Sediment yields in the tracks and logged swales were at least an order of magnitude higher than the controls. Sediment yields decreased with increasing SWR because the logging tracks had significantly less SWR. Multivariate analysis indicated that sediment yields are more closely related to percent ground cover rather than SWR. These results indicate that the disturbance due to salvage logging can reduce SWR, but the associated compaction and reduction in surface cover are more persistent and detrimental than any potential benefit due to lower SWR.