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Wildfire effects on soil carbon and nitrogen: the roles of combustion and erosion

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Many chemical and biological properties and processes occurring in soils depend upon the presence of organic matter. Soil organic matter is particularly important for nutrient supply, cation exchange capacity, and water retention, hence its importance in long-term site productivity. However, wildfires consume large amounts of aboveground organic material, and soil heating can consume soil organic matter. In almost all ecosystems throughout the world, greater quantities of carbon (C) and associated nutrients such as nitrogen (N) are found belowground than aboveground In grasslands, savannas and tundra-covered areas, much greater quantities of organic C ($>$90%) are found in the underground plant parts and decomposed organic matter than aboveground. In forest ecosystems, C is more evenly distributed aboveground and belowground (e.g. temperate deciduous and boreal forests). In general, soils with larger proportions of organic matter in the aboveground biomass and on their forest floors are more prone to wildfire-caused disturbances in their nutrient and C regimes than those in which most of the C in the ecosystem is located belowground. Overall effects of wildfire on soil C and N are a function of fire temperatures, severity, and frequency. A meta-analysis By Johnson and Curtis (2001) on the results of 13 fire studies (mixture of wildfire, routine prescribed fire, and site preparation fire) completed between 1975 and 1997 showed that the C and N contents of both the A-horizon and the underlying mineral soil layers change only a small amount ($<$10 percent) in the long-term. These results agreed with the conclusions of a previous review (Johnson 1992) that indicated the overall effect of fire was not significant although there was a significant effect of time since fire. Although small changes in soil C and N occurred in the soils during these studies, substantial amounts of both organic litter and duff (100% in high severity fires) were consumed during these fires, especially high severity areas of the

wildfires. Erosion of mineral soil, most common after high severity fires, adds little to total C and N losses since combustion alone can produce 90% removal of C and N in the upper 7.5 cm of mineral soil. Organic matter and N losses from the forest floor and surface mineral soil could have a lasting effect on the long-term productivity and sustainability of forest sites, particularly when they occur on nutrient-deficient sites. This paper examines a number of studies contrasting C and N losses due to combustion and erosion processes.