Post-Wildfire Logging Hinders Regeneration and Increases Fire Risk

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Recent increases in wildfire activity in the United States have intensified controversies surrounding the management of public forests after large fires (*1*). The view that postfire (salvage) logging diminishes fire risk via fuel reduction and that forests will not adequately regenerate without intervention, including logging and planting, is widely held and commonly cited (*2*). An alternate view maintains that postfire logging is detrimental to long-term forest development, wildlife habitat, and other ecosystem functions (*1*). Scientific data directly informing this debate are lacking.

Here we present data from a study of early conifer regeneration and fuel loads after the 2002 Biscuit Fire, Oregon, USA, with and without postfire logging. Because of the fire's size (~200,000 ha), historic reforestation difficulties in the region (*3*), and an ambitious postfire logging proposal, the Biscuit Fire has become a national icon of postfire management issues. We used a spatially nested design of logged and unlogged plots replicated across the fire area and sampled before (2004) and after (2005) logging (*4*).

Natural conifer regeneration on sites that experienced high-severity fire was variable but generally abundant, with a median stocking density of 767 seedlings per hectare, primarily of Douglas fir (*Pseudotsuga menziesii*) (Fig. 1A). Such density exceeds the regional standards for fully stocked sites, suggesting that active reforestation efforts may be unnecessary. Postfire logging subsequently reduced regeneration by 71% to 224 seedlings per hectare (Fig. 1A) due to soil disturbance and physical burial by woody material during logging operations. Thus, if postfire logging is conducted in part to facilitate reforestation, replanting could result in no net gain in early conifer establishment.

Postfire logging significantly increased both fine and coarse downed woody fuel loads (Fig. 1B). This wood was composed of unmerchantable material (e.g., branches), and far exceeded expectations for fuel loads generated by postfire logging (*4*, *5*). In terms of short-term fire risk, a reburn in logged stands would likely exhibit elevated rates of fire spread, fireline intensity, and soil heating impacts (*6*).

Postfire logging alone was notably incongruent with fuel reduction goals. Fuel reduction treatments (prescribed burning or mechanical removal) are frequently intended after postfire logging, including in the Biscuit plan, but resources to complete them are often limited (*7*). Our study underscores that, after logging, the mitigation of short-term fire risk is not possible without subsequent fuel reduction treatments. However, implementing these treatments is also problematic. Mechanical removal is generally precluded by its expense, leaving prescribed burning as the most feasible method. This will result in additional seedling mortality and potentially severe soil impacts caused by long-duration combustion of logging-generated fuel loads. Therefore, the lowest fire risk strategy may be to leave dead trees standing as long as possible (where they are less available to surface flames), allowing for aerial decay and slow, episodic input to surface fuel loads over decades.

Our data show that postfire logging, by removing naturally seeded conifers and increasing surface fuel loads, can be counterproductive to goals of forest regeneration and fuel reduction. In addition, forest regeneration is not necessarily in crisis across all burned forest landscapes.

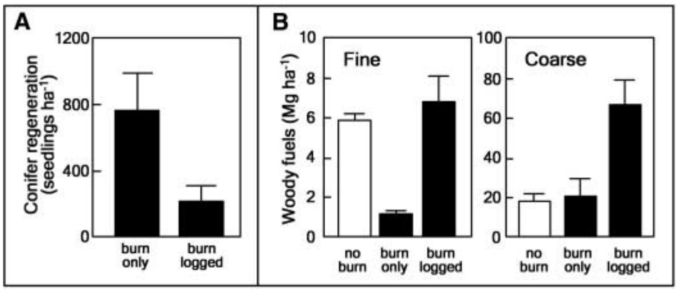

Fig. 1. (**A**) Natural conifer regeneration and (**B**) surface woody fuel loads before and after postfire logging of the Biscuit Fire, Oregon, USA. (A) shows that regeneration was abundant after the fire. Postfire logging significantly reduced seedling densities ($P < 0.01$, Wilcoxon signed rank test) from 767 seedlings per hectare to 224 seedlings per hectare. (B) shows that postfire logging significantly increased downed fine ($P < 0.01$) and coarse ($P < 0.05$) woody fuel loads (Mg ha^{-1}) relative to burn-only fuel loads by Wilcoxon signed rank test. To provide context, fuel data from unburned stands are shown as reference for prefire conditions (fuel loads in burn-logged stands were at or well above prefire levels). Graphs of seedling densities and fine (≤7.62 cm) and coarse (>7.62 cm) surface woody fuels are medians ± SE; sample size $n = 8$ stands for no burn, $n = 9$ for burn-only and burn-logged (*4*).

References and Notes

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4. Materials and methods are available as supporting material on *Science* Online.
5. Timber decay associated with delays in postfire logging was anticipated to exacerbate the observed pulse of surface fuel. However, our data indicate that delay was responsible for ~10% of the woody fuel present after logging.
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Supporting Online Material

www.sciencemag.org/cgi/content/full/1122855/DC1
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