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Interactive effects of frequent burning and timber harvesting on above ground carbon biomass in temperate eucalypt forests

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The sequestration of carbon has been identified as an important strategy to mitigate the effects of climate change. Fuel reduction burning and timber harvesting are two common co-occurring management practices within forests. Frequent burning and timber harvesting may alter forest carbon pools through the removal and redistribution of biomass and demographic and structural changes to tree communities. Synergistic and antagonistic interactions between frequent burning and harvesting are likely to occur, adding further complexity to the management of forest carbon stocks. Research aimed at understanding the interactive effects of frequent fire and timber harvesting on carbon biomass is lacking. This study utilised data from two long term (25 - 30 years) manipulative burning experiments conducted in southern Australia in temperate eucalypt forests dominated by resprouting canopy species. Specifically we examined the effect of fire frequency and harvesting on (i) total biomass of above ground carbon pools and (ii) demographic and structural characteristics of live trees. We also investigated some of the mechanisms driving these changes. Frequent burning reduced carbon biomass by up to 20% in the live tree carbon pool. Significant interactions occurred between fire and harvesting, whereby the reduction in biomass of trees >20 cm diameter breast height (DBH) was amplified by increased fire frequency. The biomass of trees <20 cm DBH increased with harvesting intensity in frequently burnt areas, but was unaffected by harvesting intensity in areas experiencing low fire frequency. Biomass of standing and fallen coarse woody debris was relatively unaffected by logging and fire frequency. Fire and harvesting significantly altered stand structure over the study period. Comparison of pre-treatment conditions to current conditions revealed that logged sites had a significantly greater increase in the number of small trees (<40 cm DBH) than unlogged sites. Logged sites showed a significant decrease in the number of large trees (>60 cm DBH) over the study period, while unlogged sites showed an increase. Frequently burnt logged sites showed the greatest reduction in large trees, presumably due to increased fire related mortality and collapse. Analysis of tree survival and growth data suggest that mortality rate is increased and growth rate reduced in frequently burnt areas compared to unburnt areas. Our findings suggest that future shifts towards more frequent fire (both prescribed fire and wildfire) could potentially lead to broad scale reductions in carbon sequestration in temperate forests and woodlands dominated by resprouting canopy species. Reductions in carbon sequestration associated with frequent burning will potentially be amplified in intensively harvested landscapes.