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Is pre-commercial thinning compatible with carbon sequestration? A case study in a maritime pine stand in northwestern Spain

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Summary

The mid-term effects on carbon sequestration of two consecutive pre-commercial thinnings with different intensities were analysed in a heavily stocked *Pinus pinaster* Ait. stand in northwestern Spain. Thinning was carried out 5 and 8 years after seedling establishment. Intense thinning reduced the initial sapling density by 92 per cent after the first treatment and by 87 per cent after the second; moderate thinning reduced the density by 82 per cent after the first treatment and by 84 per cent after the second. The effect on foliar efficiency of the first thinning was transient, but was prolonged by the second thinning. Live carbon biomass stock (in saplings and understorey) decreased after thinning, especially after the most intense thinning. However, when residues were taken into account, the carbon biomass decreased by only 18 per cent in the intensely thinned plots, and by 2 per cent in the moderately thinned plots, relative to the untreated plots, by the end of the study period. Very early thinning of these heavily stocked young stands was found to have a reduced mid-term effect on carbon sequestration per land area, when carbon stock from understorey and residues were considered.

Introduction

Fire is one of the greatest potential risks to loss of stored terrestrial C (Kashian *et al.*, 2006; van der Werf *et al.*, 2006; Wiedinmyer and Neff, 2007) and is a loss pathway that is difficult to quantify because of the high degree of spatial and temporal variation in fire emissions (Wiedinmyer and Neff, 2007). Pulsed emissions of CO_2 during fires are assumed to be partly counterbalanced via the uptake of CO_2 by regrowing vegetation in the decades following fire (Wiedinmyer and Neff, 2007). In forests of the Iberian Peninsula, where wildfire is a major and frequent perturbation, the post-fire recovery rate may be important in regional scale carbon storage because carbon lost in stand-replacing fires is often a significant component of regional carbon budgets (Kashian *et al.*, 2006; Wiedinmyer and Neff, 2007). Short-term effects of fire will be important for the carbon balance in this century because the expected higher fire frequency (Ministerio de Medio Ambiente, 2005; Vega *et al.*, 2009) will release large amounts of carbon through combustion, and increase the forested area with negative net ecosystem production (Litton *et al.*, 2004; Kashian *et al.*, 2006; van der Werf *et al.*, 2006; Wiedinmyer and Neff, 2007). Moreover, depending on the forest type, the area burned by a stand-replacing fire may not recover its pre-fire C stock for decades (Wirth *et al.*, 2002). In post-fire regenerated stands, thinning and shrub removal may have a significant impact on the magnitude of net carbon fluxes, with conversion of the ecosystem from a sink to a source of CO_2 in the short term (Misson *et al.*, 2005; Hurteau *et al.*, 2008; Hurteau and North, 2009). In this context, it is important to quantify the effects of thinning of heavily stocked fire-origin stands on carbon accumulation in trees. Available information on this topic is still