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Reduction of stand density as a management tool to mitigate the effect of drought

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An increasing frequency and severity of drought combined with increased competition due to reduced forest management practices are putting many Scots pine forest (Pinus sylvestris) under increased drought pressure. Declining pines are already been observed in many drought exposed regions as in southern Europe or in the dry inner Alpine valleys. Thus, forest management practices oriented at reducing competition for water should increase pines tolerance to climate change and thus enhancing their long-term mitigation potential. In this study, we are testing the beneficial effect of thinning and understory removal as possible management practices.

As a first study object we selected a trial with 3 thinning intensities (basal area reduction of 15%, 46% and 70%) and one control (unmanaged forest). The second experiment consisted in removing the understory layer in a radius of 5 meter from 6 mature pine trees. Water-related indicators, such as soil water content, sapflow, point dendrometer and ring width measurements over the growing season were then compared with control trees. Both objects belongs to the pine forests from the dry Rhone valley.

Our results indicates that over the 10 years following the thinning performed in 1965 (when the stand was 45 years old) doubled and quadrupled the basal area increment in the medium and heavy treatments compared to the control. The annual mortality rates for the period 1978-1990 ranged between 2.9% for the control and 0.8% for the heavy thinned stand. An increasing mortality rates during the period 1991-2009 (up to 3.3%), with consequent decline in basal area and carbon sequestration, has been observed in relation to high remaining stand density.

The removal of understory performed in April 2010 increased soil water content at 30 cm and 65 cm depth reducing trees drought stress. The transpiration and the predawn leaf water potential of overstory trees were higher in the trees with removal of the understory vegetation. The same trees also showed delayed stomata closure during drought periods. This advantage eventually resulted in a significant increase in tree growth, which was observed in the second year after removal.

This combining approach highlight the positive effect of competition removal of growth and vitality of Scots pine trees. Our results suggest that in dry forests of the inner-Alps or the Mediterranean region, a strong reduction of basal area (15-25 m2/ha) is suitable to preserve enough water availability to maintain and healthy state. If thinning lead to a major increase of the understory layer, understory removal would prolong the initial positive effect of thinning. Thinning and understory removal enhance tree vitality and increase tree resistance against drought, insects and pathogens. These results simultaneously suggests that pine decline is not driven only by the increase of temperature, but is also a consequence of a change of forest use, specifically for the Valais, to a reduction of goat grazing pressure and wood harvesting.