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Interspecific differences of long-term fire effects on xylem hydraulics

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Forest fires of moderate intensity, which are not lethal for trees, can leave behind partially damaged mature trees. Surviving trees often show an enhanced mortality rate in the following years. Recent studies on post-fire tree mortality suggest heat-induced alterations of the hydraulic system to play an important role as a mechanism governing delayed tree death. We studied heat-related impacts on the hydraulic system of three different tree species both in the laboratory and at a forest fire site.

Experiments were performed on *Picea abies*, *Pinus sylvestris* and *Fagus sylvatica* and xylem hydraulic parameters analyzed: Based on the cavitron method, heat effects on the vulnerability to drought-induced cavitation were quantified ($\Psi_{50,}$water potential at 50% loss of conductivity) and the hydraulic conductivity determined. Control branches were compared with samples experimentally exposed to 90˚C or damaged by a natural forest fire. In addition, electrical resistivity tomograms (ERT) of boles of control and fire-affected trees were analyzed.

Experimental heating caused an increased vulnerability in all species, with pronounced shifts in vulnerability thresholds in *P. sylvestris* (Ψ_{50}−3.59 $\pm$ 0.09 MPa to -2.33 $\pm$ 0.14 MPa) and *F. sylvatica* (Ψ_{50}−2.80 $\pm$ 0.08 MPa to -2.17 $\pm$ 0.08 MPa). At the forest fire site, increased vulnerability was observed in damaged branches of *P. sylvestris* and *F. sylvatica*. In heat experiments and at the forest fire site, branches of *F. sylvatica* showed reductions (49% and 39%, respectively) in hydraulic conductivity upon heat exposure. Bole ERT tomograms of fire-affected and control trees of *P. abies* clearly differed, while the forest fire had no recognizable impact on the ERT patterns of *P. sylvestris* and *F. sylvatica*.

Results underline the species-specificity of long-term fire effects on xylem hydraulics. Heat exposure during a forest fire can induce permanent hydraulic impairments of surviving trees, whereby damage of bole sections, as indicated by ERT analysis, may be most critical. These post-fire effects increase the likelihood of hydraulic failure under drought conditions and should be considered for risk assessments of post-fire damages.