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Modelling the dynamics of Pinus sylvestris forests after a die-off event under climate change scenarios

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In recent decades, die-off events in *Pinus sylvestris* populations have been on the rise. The causes of these phenomena, which are usually related to local and regional extreme hot droughts, have been extensively investigated from a physiological viewpoint. However, the consequences of the die-off process in terms of demography and vegetation dynamics have been less thoroughly addressed. Here, we projected *P. sylvestris* plot dynamics after a die-off event, under climate change scenarios, considering also their early stages (i.e., seedlings, saplings and ingrowth from the sapling to adult class), to assess the resilience of *P. sylvestris* populations after such events. We used IPM methodologies to project future plot structure under three climate scenarios (current climate, RCP4.5 and RCP8.0 projections), using climatic suitability – extracted from Species Distribution Models – as a covariable in the vital rates over time. Field data feeding IPM were obtained from two successive surveys, at the end of the die-off event (2013) and four years later (2017), undertaken on populations situated across the *P. sylvestris* range of distribution in Catalonia (NE Spain). Plots affected by die-off experienced a loss of large trees, which results in their basal area, tree diameter and tree density remaining lower than those of unaffected plots for decades. This situation is partially counterbalanced after the event in affected plots by a greater increase in the basal area and in seedling recruitment into the tree stage, thus promoting resilience. However, resilience is delayed under the climate-change scenarios with warmer and drier conditions involving additional physiological stress, due to a reduced abundance of seedlings and a smaller plot basal area. Overall, the study shows the lagged effect of drought-induced die-off events on forest structure and reveals stabilizing mechanisms which enhance resilience, such as recruitment and tree growth release. These mechanisms are apparently jeopardized, however, by regional warming.