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Tree ring carbon isotopes record predisposition to drought-induced mortality and survival.

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Drought-induced tree mortality is predicted to increase in intensity and frequency in mid-latitude regions over the next 50 years. We report on tree ring records of growth and carbon isotope discrimination in a variety of species from N. America and Europe that demonstrate a consistent pattern of predisposition to mortality during drought. Trees that die show greater sensitivity of growth to climate as has been previously demonstrated. Trees that die; however, have consistently lower discrimination and significantly less sensitivity of discrimination to climate than trees that survive. A simple hydraulic model based on Darcy's law successfully recreated the observed patterns of discrimination, and supports the interpretation that trees that die have consistently lower leaf-level stomatal conductance than trees that survive. Furthermore, the model supports the conclusion that these trees are less responsive to inter-annual climate variation due to chronic water stress. It appears that such chronic water stress predisposes trees to mortality. Consideration of the sensitivity of these isotope records to mesophyll conductance, photosynthetic capacity, photorespiration, and carbon recyling is critical to robust conclusions. Continued intensification of drought in mid-latitude regions may force trees undergoing chronic water stress to undergo increased mortality, resulting in ecotone shifts and regional mortality events in temperate forests.