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Root system reserve status, a potential barometer of carbon limitations in trees

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Carbon reserve allocation in trees is an important factor in tree growth and survival which in turn influences the distribution of species and forest communities and their associated carbon, water and energy fluxes at multiple scales. We still lack a comprehensive understanding of the underlying mechanisms of carbon reserve allocation in trees and how they might be influenced by drought, biotic attack, and stand age. This is particularly true for mature trees. Over a period of eight years seasonal non-structural carbon reserves (NSC) were followed in different organs of mature aspens (Populus tremuloides Michx.). Foliar, twig, stem and root tissues were sampled. Over the eight years some of the aspen clones were defoliated in 2000, 2001 and/or 2007; results indicate that after the defoliation events the NSC reserves in the roots required much longer to recover than the NSC reserves in the twigs and stems of the crown. While reserve recovery in twigs was almost immediate in defoliated trees, root starch reserves recovered only fully after two growing seasons to values comparable to undefoliated trees. These results suggest that an allocation priority could exist, which in large part might be determined by a tissue's proximity to the canopy (crown). It is hypothesized that this would be most noticeable in tall trees with small live crown ratios resulting in greater carbon reserve withdrawal along the bole. This top-down allocation could result in carbon reserves shortages in the roots during carbon limitation, which could feedback on to the canopy, further reducing aboveground growth and potentially also resiliency to future stresses.