Supplementary Information 6: Scaling net changes in nonstructural carbon reserves

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Availability of underlying code

This pdf was generated from an Rmarkdown file, which includes all R code necessary to reproduce the estimatations. The Rmarkdown file is available on github: https://github.com/TTRademacher/Exp2017Analysis.

Calculating nonstructural carbon reserves for the 2017 experiment at Harvard Forest

To estimate changes in soluble sugars and starch (measured as glucose equivalent) for various tissue, we scaled the concentrations derived using colorimetric assays as described in the methods. Below, we describe the scaling for easily accessible nonstrucutral carbon reserves in stem sections, for entire stems, roots and leaves, as well as the whole-tree reserves. The net differences in reserves over time (i.e., four sampling points) provide estimates of net gains or losses of soluble sugars and starch for each stem section. Generally, scaling involved multiplication of nonstructural carbon concentration by an estimate of tissue dry matter similar to Furze et al. (2019). Below we provide exact methods and examples for each tissue.

For stem sections

We measured nonstructural carbon concentrations for the first and second centimeter of the stem core (from the cambium towards the pith) as detailed in the methods section. While nonstructural carbon concentrations follow a generally decreasing gradient from the bark towards the pith (Furze et al., 2019; Hoch et al., 2003), we only consider nonstructural carbon reserves in the first two centimeters underlying the bark for each stem section. The second centimeter already showed substantially smaller changes from July to November (Fig. S3) than the first centimeter. Because reserves in even deeper tissues are generally smaller (Furze et al., 2019; Hoch et al., 2003) and are assumed to be less accessible (Carbone et al., 2013), we limit our analysis to the first two centimeters.

Assuming that that our measurements are an adequate average of these reserves, we derive the total mass of nonstructural carbon in sugars and strach ($M_{sugar,i}$ and $M_{starch,i}$, respectively) by multiplying the dry matter of the hollow cylinder (M_i) of each stem section i with the section's measured concentrations of sugar and starch ($c_{sugar,i}$ and $c_{starch,i}$, respectively). For sugar this is expressed as:

$$M_{sugar,i} = c_{sugar,i} \times M_i = V_i \times \rho_w \times c_{sugar,i}$$

The mass of a hollow cylinder representing the outter most centimeter of material (e.g., 0-1 cm; $M_{i,0}$) is derived from its volume ($V_{i,0}$) and an average wood density (ρ_w). Here, 289.9± 40.4 $kg\,m^{-3}$ was used as wood density, which is the mean ± standard deviation of wood density of 16 cores from nine trees in the control group as determined using x-ray film (Björklund et al., 2019). The volume is calculated using a height (h) of 10 cm and the section's circumference (cbh_i; in cm), which was measured in the field using a tape measure.

$$M_{i,0} = V_{i,0} \times \rho_w = \pi \times h \times \rho_w \Big(\Big(\frac{cbh_i}{2\pi} \Big)^2 - \Big(\frac{cbh_i}{2\pi} - 0.01 \Big)^2 \Big)$$

Analogously, we calculated the mass of a hollow cylinder representing the second outter most centimeter of material (e.g., 1-2 cm; $M_{i,1}$) is estimated as follows.

$$M_{i,1} = V_{i,1} \times \rho_w = \pi \times h \times \rho_w \Big(\Big(\frac{cbh_i}{2\pi} - 0.01 \Big)^2 - \Big(\frac{cbh_i}{2\pi} - 0.02 \Big)^2 \Big)$$

For example, a 10 cm high stem section of 20 cm diameter, would have a volume of 628 cm^3 and a mass of 182.06 g. At an average measured sugar and starch concentration of 0.83 and 0.28 $\%\, dry\, mass$ in July, this equates to a total nonstructural carbon reserve of roughly 2 g or 1 g of easily accessible carbon in that stem section.

References

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