

Research Project

Minimum levels of carbon reserves in temperate trees at severe carbon limitation and drought stress (MinCarbRes)

Third-party funded project

Project title Minimum levels of carbon reserves in temperate trees at severe carbon limitation and drought stress (MinCarbRes)

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Project Website <https://botanik.unibas.ch/forschungsgruppen-der-botanik/nachhaltige-landnutzung/projects/mincarbres>

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A detailed understanding of the carbon (C)-relations of trees is key to understand their physiological reaction to climatic change and the associated changes in biochemical cycles at the local and global scale. An increasing number of studies are using carbon reserve concentrations of plant tissues as proxies for a plant's net C balance. Especially with respect to the effect of environmental stress like drought, analyses of non-structural carbohydrates (NSC) reserves have been frequently used to assess the absence or presence of C-limitation for growth and survival of trees, assuming that NSC concentrations are largely mirroring C-over or -undersupply. However, recent research questioned the indicative value of C reserve concentrations for a plant's C-relation, emphasizing the active nature of reserve formation, which can also occur against prevailing C-sink demands, and thus might be in direct competition with growth. Within this research project we will address fundamental, but so far largely unexplored questions regarding the dynamic of C storage in trees to better assess the potential of C reserve tissue concentrations as indicators of a plant's C balance.

In detail, we are aiming to (1) monitor the effects of severe shading on growth and C storage of tree saplings by sequential harvests over the course of 2.5 years, in order to identify the reaction of non-structural C reserves to long-term C-limitation and to identify possible trade-offs between growth and storage. To arrive at general patterns and identify species-specific differences, we will investigate different tissues of 10 temperate tree species from 5 different functional types. In an additional experiment, we will (2) investigate the absolute minimum concentrations of different C reserve compounds (NSC and lipids, but also cell-wall hemicelluloses as potential reserves) by exposing saplings of four different species (two deciduous broad-leaved, two evergreen conifers) to either continuous darkness or repeated defoliation until the death of the saplings due to C-starvation. Finally, (3) after one growing season, a subset of shaded and un-shaded trees from the long-term shading experiment will be treated with continuous drought, in order to test the significance of the initial C reserve tissue concentrations for the survival of tree saplings under hydraulic stress. This experiment will again use two deciduous broad-leaved and two evergreen conifer species. In addition, we will apply ¹³C-pulse labeling at different dates into drought to assess the effect of hydraulic constraints on the phloem transport of current photoassimilates and the persistence of newly formed C-reserves under drought.

The experiments planned for this project will deliver very basic information that has not been addressed systematically so far. The project will significantly contribute to close a major gap in our understanding of

the C relations and C reserve dynamics in trees. The main applicant, Günter Hoch, and the co-applicant, Arthur Gessler, are both established researchers in the field of the ecophysiology of C reserves and stress physiology of plants. This project will further run in collaboration with the research group of Prof. Simon Landhäusser, University of Alberta, Canada, who will simultaneously perform complementary experiments on the C reserve dynamics of aspen trees under C-limitation. Because the comparative analyses of C reserve tissue concentrations has become a widely used tool to assess the C relations of plants, the gained knowledge on the physiological minimum values of C reserve concentrations, possible growth-storage trade-offs under C-limitation, and the significance of C reserves for drought survival, will be of prime importance for all researches working on the C dynamics of plants, especially with respect to climate change effects. The comparison of several species and functional tree types will further deliver implications for our understanding of climate-driven species distribution and forest composition, and the deriving consequences for the ecosystem fluxes of C, water and nutrients.

Keywords carbon starvation, trees, non-structural carbon reserves, source-sink balance, drought stress, carbohydrates, ¹³C labeling, forest ecology

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3395339	Hoch, Günter	Landhäusser, Simon, Professor	University of Alberta	01.01.2015	31.12.2017