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| **Productivity and Complexity – Linking two fundamental characteristics of trees and forests** |
| **Introduction:**  Several studies could already show that structural heterogeneity is positively related to stand level productivity. This relationship is assumed to be the result of complementary resource utilization or spatial niche-partitioning in canopies as a result of variations in species, age or dominance. Our knowledge of which structural traits of individual trees in a stand are related to the increased productivity of the stand community is however still limited. To date, increased canopy packing has been related to greater light interception, and greater light interception could be directly related to increased productivity. At the same time, increased canopy packing has also resulted in greater structural complexity, which has also been associated with greater productivity. Besides the optimal utilization of canopy space, complex growth might also favour productivity by increasing a tree’s resource use efficiency. By creating a larger photosynthetically active area with the same or even less woody biomass, complex trees would exhibit a larger surface-area-to-volume ratio which could enable a higher benefit-to-cost ratio, since the constructing wood comes with maintenance costs. Within this study we want to further investigate why complex growth is beneficial for the productivity of trees and forests.  **Study design:**  The research training group EnriCo investigates the consequences of enriching European beech with native (Norway spruce) and non-native (Douglas fir) conifers in Central European forests. A quintet design comprising a set of three pure plots (European beech, Douglas-fir, Norway spruce) and two of the respective beech-conifer mixtures is established at eight locations throughout northern Germany. All of these 40 plots were scanned in 2021 using a mobile laser scanner (Geoslam ZEB-horizon). A subset of 20 plots were manually segmented, which provides around 1300 trees for further analysis on tree level. Besides most common tree characteristics, we will use the Box-Dimension (Db) as one holistic parameter describing a tree’s structural complexity. To get detailed information on the woody biomass of each individual tree, Quantitative Structure Models will be applied. As a proxy for productivity, we will use DBH measurements made in the field in 2017 and 2021 to derive basal area increment measures.  **Expected results:**  Deriving the crown surface area of each tree and its respective volume, we will test the surface-volume ratio of each tree against its Db. This link was shown before but is the foundation for the intent of this project. Thereafter we will test the complexity of each tree against its productivity. The same will be done on plot level. Expected results are strong positive correlations between productivity and complexity, as these links were reported in the literature before. Since we know, how much each tree contributes to the plot complexity and productivity, we can further investigate the importance of individual complex growth to the overall productivity. Therefore, we expect a somewhat exponential relation as we hypothesize, that the most complex trees also contribute most to the overall plot productivity. |