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Vertical and horizontal root distribution of mature aspen clones: mechanisms for resource acquisition

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Spatial root distribution, root morphology, and intra- and inter-clonal connections of mature boreal trembling aspen clones (*Populus tremuloides* Michx.) were explored to shed light on the functional relationships between vertical and horizontal distribution of roots and the variation in soil water availability along hill slopes. Root systems of mature aspen were hydraulically excavated in large plots (6 m wide and 12 m long) and to a depth of 30 cm. Most aspen roots were located in the upper 20 cm of the soil and fine and coarse root occupancy was highest in the lower slope positions and lowest towards the upper hill slope position likely because of soil moisture availability. Observation of the root system distribution along the hill slope correlated well with the observation of greater leaf area carried by trees growing at the lower portion of the hill slope. Interestingly, trees growing at the bottom of the slope required also less sapwood area to support the same amount of leaf area of trees growing at the top of a slope. These observations appear to be closely related to soil moisture availability and with that greater productivity at the bottom of the slope. However, trees growing on the upper slope tended to have long lateral roots extending downslope, which suggests long distance water transport through these lateral feeder roots. Genetic analysis indicated that both intra- and inter-clonal root connections occur in aspen, which can play a role in the sharing of resources along moisture gradients. Root systems of boreal aspen growing on upper slope positions exhibited a combination of three attributes (1) asymmetric lateral root systems, that are skewed downslope, (2) deeper taproots, and (3) intra and inter-clonal root connections, which can all be considered adaptive strategies to avoid drought stress in upper slope positions.