

Supplementary Materials

Table S1. Field measurements description values range. SPH = stems per hectare; MTH = mean top height; Mean CrHT = Mean crown height.

Plot Number	Plot status	Site index	Plot size (ha)	Age (years)	SPH (/ha)	MTH (m)	Mean CrHt (m)
20	Current	26.8-33.8	0.09	9-12.85	600-933	11-22.5	3.8-5.1

Crown competition metrics

A canopy height model (CHM) with 0.25 m resolution was extracted from ALS data collected over the trial area (PEF in this study) and image defects referred to as pits were removed using the standard image processing method closing (Ronse and Heijmans, 1991; Andersen et al., 2006). Individual trees were detected and crown boundaries determined on the CHM image using the calibrated ITC method (Pont et al., 2015). Detected trees were matched to ground trees with an automated least squares approach (Hauglin et al., 2014) and unmatched trees used to identify and manually correct segmentation errors.

The segmentation resulted in one growing space polygons per detected tree, which completely tiled to produce the final image, each including a tree crown and a portion of any adjacent gap between trees. So that all space was divided amongst the trees with no unallocated space. Tree crown boundaries were then delineated within each growing space polygon to exclude any gap area. For tree crowns with no adjacent gaps, growing space and crown polygons were identical. Growing space boundaries, crown boundaries, and crown elevation values were used to derive a total of nine crown size metrics (Table 2) correlated with the traits of interest (Pont, 2016). Crown volumes (CVF and CVP) quantified three-dimensional crown size, while surface areas from projected polygon outlines (GAP and CAP) and from surface areas of three-dimensional crown surfaces (CSC and CST) provided two-dimensional measures of crown sizes. Crown length and radius (CL and CR) provided one dimensional measure and the ratio of crown and growing space areas (AGC) provided a dimensionless measure of crown size. These crown size metrics were then used in competition metrics described subsequently.

Rouvinen and Kuuluvainen (1997) presented a set of competition metrics, CI10, CI11, and CI12, derived from the original by Hegyi (1974). Those competition metrics were evaluated by Suárez (2010) using ground measured DBH and using DBH estimated from LiDAR CHM crown metrics, among them the boundary method used in this study (Equation 1). In the boundary method (NB), only trees sharing a segment boundary (as delineated on the CHM) with the target tree were included (Suárez, 2010). Processing of the CHM included a 50 m buffer around the trial and competition metrics using both neighborhood methods included trees surrounding the trial, a distinction with competition metrics which often only account for trees measured within plots or trials (Dutkowski et al., 2006).

Table S2. Generalized mixed-effect models' goodness-of-fit comparison.

Model	RMSE (m)	AIC	BIC
Null: $\Delta HT \sim 1$	1.50	-4762.607	-4741.8
Full: $\Delta HT \sim$ All possible combination of explanatory variables.	0.85	-781.175	-732.633
Final: $\Delta HT \sim CV_F + SD + (CV_F \times SD)$	0.92	-6588.58	-6546.97

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