Continuing Project

Determination of crown morphological traits using laser scanning in Douglas-fir and loblolly pine genetics trials

Project 23.103

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- Improved performance of genetically select trees has been associated with specific heritable crown morphological traits.
 - High leaf area density
 - Short branches, narrow crowns

- Advantages in carrying capacity gained in pure family blocks may be lost in family mixes
- Narrow crowns and high leaf area density imply spatially efficient trees, conforming to the crop ideotype concept





Justification

- Efficient means of identifying families exhibiting heritable morphological traits would make deployment a more practical possibility
- Accounting for heritable crown traits within growth and yield equations would provide a more descriptive means of predicting the benefits of deploying specific families of known traits



Justification

- Pure family ideotype-representative Douglas-fir plantations are available
- With enough pure families identified, it is expected that the range in potential performance within an ideotype would be represented
- Initial densities represented
 - 6 x 6 ft (current age: 27 yrs)
 - 9 x 9 ft (current age: 22 yrs)
 - 12 x 12 ft (current age: 27 yrs)
- Available plantations are increasingly fragile



Feb. 2024 Post-laser scan; Pre-measurement



Objectives

- Assess whether the crown morphological features that are associated with improved performance can be identified using drone-based laser scanning, thereby providing a tool able to efficiently identify individual trees/families with characteristics of interest
- Assess whether crown morphological features that are associated with improved performance be accounted for in growth models





Methods: laser scanning

- Conduct laser scanning of 3 pure family plantations
 - Matrice 300 RTK drone and L1 lidar sensor, ~450 points/m²
- Point cloud processing by our FPC partners
 - Matthew Sumnall, Va. Tech

Narrow crowns

- Process developed for loblolly pine
- Explore correlations between laserscanned and measured crown variables

Wide crowns







Methods: measurements

- Measure trees at three sites
 - Family deployment study (Mill City, 27 yrs, 8 families, replicated)
 - Six G's (Walton, 38 pure families, unreplicated)
 - Site destroyed by heavy snow following drone flight but prior to measurement
 - Middle Overlook (Coquille, 78 pure families, unreplicated; only 33 families used)
- Measurements
 - DBH, Ht, HCB, 4 crown widths per tree
 - 2 diagonals, 2 perpendiculars per tree (~1400 trees) across the DBH distribution





Major findings: matching laser scan data to individual trees

- Matching coordinates with individual trees is more difficult with increasing differentiation
 - e.g. narrow crowned families vs. woods run
- Identification of individual trees is easier at lower densities
 - Matching remotely estimated data with measured DBH, HT, HCB, CW, worked for 12x12, not for 6x6







Center for Advanced Forestry Systems 2024 IAB Meeting

Major findings: Remotely-estimated allometry

 Among matched trees, there was poor correlation between scan-derived and measured variables







Major findings: LAI estimates

- Poor match between laser scan LAI estimates and crown density estimates from destructive sampling at age 9
- Positive trend of LAI with crown width suggests laser penetration of canopy gaps

 $CW_{av} = a + (b+s) \cdot DBH + c \cdot DBH^2$









Major findings: CW vs. DBH

- Used mixed model to predict CW_{av} from DBH
 - CW_{av}= a + (b+s)•DBH + c•DBH² where s is a random variable for family
- Wide crowned families (WCF) and narrow crowned families (NCF) were identified using significant positive or negative values of s.
- FDS: 2 WCF and 2 NCF;
 MO: 6 WCF and 7 NCF
- Using predictive CW equation with WCF, NCF, and Woods run (WR) found:
 - **NCF were significantly narrower than WR; WCF didn't significantly** differ from WR
 - Average improved tree had a narrower crown than WR
 - Based on equation, crowns of narrow crowned families were estimated to be 11.086% more narrow than woods run





Family crown widths over time

- Crown width measurements at FDS were made at age 12 and age 27
 - $CW_{av} = a + (b+s) \cdot DBH + c \cdot DBH^2$
 - Rankings have changed over time: most extreme CWs at age 12 are not significantly different from average at age 27



Results: CW vs. predicted HCB

- Compared measured HCB to CIPSANON-predicted HCB
- HCB tended to be underestimated (positive residual) for wide crowned families (WCF); overestimated for narrow crowned families (NCF)
- NCF: had longer crowns than current equations predict
- WCF: had shorter crowns than current equations predict
- Provides avenue for representation within G&Y model: CCFL is a variable within the HCB equation







Increment predictions for narrow- or wide-crowned trees

- Current dbh increment residuals for NCF are similar to trees of average crown characteristics; WCF dbh increment is currently overpredicted and needs additional attention.
- Current CW equations in CIPSANON are based on trees sampled in southern Oregon—which correspond to narrow crowned trees of the current dataset
- Comparison of dbh-adjusted max crown widths from multiple SMC sites and the CIPSANON database across a limited diameter range (5-30 cm) show a range in max crown width slopes, with siteassociated crown width random effects values estimable with environmental predictors





Deliverables

- Tested algorithm for estimation of crown traits from laser scan data
- Dataset of measurements from field sites
- Report with final models describing adjustment of G&Y equations to account for crown traits
- Public presentation of findings at CAFS Annual Meeting and regional Coop meetings
- Draft manuscript for peer-reviewed journal





Summary

- Laser-scan derived estimates of crown characteristics within well-differentiated, high-density stands were not well correlated with measured values.
- Improved genetic selections had narrower crowns than woods run. Wider than average crowns didn't differ from woods run.
- Families exhibiting most extreme narrow/wide crowns at age 12 are not the same as those significantly different from average at age 27.
- DBH Increment residuals of narrow crowned trees projected within CIPSANON is currently acceptable, probably due to the system's current narrow-crown width dataset. Increment predictions of wide crowned trees need additional effort.



