

## **Delineation of individual tree crowns for LiDAR tree and stand parameter estimation in Scottish woodlands**

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There is an increasing need for accurate forest inventories to assist forest managers and decision-makers in the planning of their forest resource. Airborne LiDAR methods enable the construction of Tree Canopy Models (TCM) at a fine resolution, thereby facilitating the delineation of individual tree crowns. This information can be useful in predicting forest parameters such as top height, basal area, standing volume and biomass. In this paper, we present a comparative analysis of the algorithms developed independently by Gougeon (1995), Popescu (2003) and Weinacker (2002) for delineating individual tree crowns, and as a means to extract forest parameters. The comparison was achieved as follow. Firstly, the algorithms were tested in their efficiency for delineating tree crowns. Secondly, single tree parameters were estimated using the crown delineation and finally, stand parameters were estimated by averaging single tree parameters. Results of the three algorithms were compared to each other and to field measurements.

The results presented for Popescu, Weinacker and Gougeon respectively, were as follow: 78%, 111% and 67% of field measured trees were delineated. However only 65%, 69% and 53% of the delineated trees were correctly associated with the field measured trees. The tree parameters estimated from the delineated trees were: tree height, crown diameter and stem diameter. The RMSE (%) for tree heights were 1.88m (7.77%), 2.23 m (9.28%) and 2.06 m (8.55%). Crown diameter was estimated with a RMSE (%) of 2.46 m (44.7%), 2.42 m (44%) and 1.78 m (31.9%) while results for stem diameter show a RMSE (%) of 8.62 cm (28%), 8.76 cm (28.9%) and 7.07 cm (22.5%). At the stand level, top heights were estimated with a RMSE of 0.92 m, 1.41 m and 1.67 m and basal area with a RMSE of 18.11 m<sup>2</sup>/ha (46.7%), 10.53m<sup>2</sup>/ha (27.1%) and 16.07 m<sup>2</sup>/ha (41.4%) respectively. Finally, volume was also estimated with a RMSE of 196.31 m<sup>3</sup>/ha (47.4%), 126.29 m<sup>3</sup>/ha (30.5%) and 186.08 m<sup>3</sup>/ha (44.9%). All the methods underestimate field based tree and stand parameters. However, it is shown that individual tree heights and stand top heights can be estimated as accurately as from field based approaches.