

Comparison of Crown Ratio Models for Spruce -Fir Broadleaved Mixed Forest Based on Beta Regression and Random Forest Algorithm

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Abstract: Tree crown is an important variable in growth and yield models. Crown ratio (CR) is one of important crown characteristics influenced by individual tree, competition, site, and stand factors. The CR models based on beta regression and random forest algorithm were developed using a dataset of fir from a total of 10,069 trees within 300 long-term fixed plots of spruce-fir broadleaved mixed forest in Changbai Mountain National Nature Reserve, Northeast China. Given that crown characteristics and growth habits vary with tree species, the dataset was divided into four tree species groups (Spruce-Fir, Hard-broadleaved, Soft-broadleaved, and Coniferous groups). Based on the modeling and validation datasets, the CR models utilized the random forest (RF) algorithm significantly outperformed the beta regression. The RF model had high prediction precision and without significant heteroscedasticity. However, beta regression may be quite suitable for modeling other ratios in the interval (0,1). The Spruce-Fir tree species group had the best performance either beta regression mode or RF model, which is in line with the expected results. Since the models with the total tree height (H) as independent variable fitted extremely poor, height to crown base (HCB) was chosen to replace H. Among these variables, the individual tree variables (diameter at breast height (DBH) and HCB) contributed the most to the CR model, followed by competition variables (competition index based on intersection angle (aCI), differentiation (Ti) and neighborhood comparison (Ui)), and finally stand variables (Gini coefficient based on basal area (Gini_BA) and dominant height regardless of the species in the case of a mixed stand (HT) and largest diameter regardless of the species in the case of a mixed stand (DT)). The CR model can be applied to multi-species mixed forest and can provide a reference for regulating the stand structure of spruce-fir broadleaved mixed forest and promoting forest quality.