COMMENT

# Stability and density management in Douglas-fir plantations[1]

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In their recent *Canadian Journal of Forest Research* article, Wilson and Oliver (2000) developed an equation for predicting the average ratio of height to diameter at breast height for the largest 250 trees/ha ($H/D_{L250}$) in unthinned stands as a function of initial density and dominant height of the stand. They then compared predictions from this equation to predictions of $H/D_{L250}$ from (*i*) the southwestern Oregon version of the ORGANON (Hann et al. 1997) growth model (SWO-ORGANON), (*ii*) the Stand Management Cooperative version of ORGANON (SMC-ORGANON), and (*iii*) the Pacific Northwest variant of the Forest Vegetation Simulator. They found that predictions of $H/D_{L250}$ from both versions of ORGANON were "…considerably higher (beyond 15 m of height)…" (p. 914) than predictions from their equation. They concluded that, "Users should critically evaluate growth model predictions of partial distribution statistics, such as $H/D_{L250}$, before they are employed" (p. 917).

As a forest modeler with 25 years of experience, I certainly agree with this warning to users of growth models, and as the primary architect and developer of ORGANON, I am always concerned when users, such as the authors, raise concerns about the predictive ability of the model. Unfortunately, the authors' description of the data sets used in their analysis was so vague (i.e., "…a representative plantation at a variety of initial Douglas-fir densities;" p. 913) that it was impossible to reproduce and examine their results directly. This problem was resolved by contacting the senior author who promptly supplied the missing detailed description of the data and copies of the initial tree lists used to make the ORGANON runs.

A close examination of these data and of the methods and results that were reported by the authors indicates that there are at least three problems with their application of the two ORGANON versions that seriously cloud the veracity of their findings.

(1) The starting tree lists used as input to ORGANON for the six planting densities were generated by the authors (J.S. Wilson, by e-mail), resulting in unrealistic tree lists. The lack of realism is demonstrated in the authors' Fig. 4, which shows that the initial values of $H/D_{L250}$ (i.e., at a dominant height of approximately 6 m) for the tree list data used to make the ORGANON runs varied from 75.6 for a planting density of 500 trees/ha to 82.2 for a planting density of 3500 trees/ha, resulting in a range of 6.6 in the $H/D_{L250}$ values. On the other hand, predicted values from the authors' equation at a dominant height of 6 m varied from 63.7 for a planting density of 500 trees/ha to 90.5 for a planting density of 3500 tress/ha, resulting in a range of 26.8 in $H/D_{L250}$ values. Hence, the tree lists used to make the ORGANON runs started with only one-quarter of the range in $H/D_{L250}$ than would be expected from the authors' equation (and the raw data shown in Fig. 2).

    Other indicators of unrealistic input tree lists include the presence of $H/D$ values as large as 960 for some trees, and a constant crown ratio of 0.8 for all trees on a plot and across all planting densities. The use of unrealistic starting tree lists can lead to unrealistic predictions from ORGANON, and as a result, the comparisons and resulting conclusions made by the authors were invalid.

(2) The starting tree lists represented plantations with a total age of 10 years and a Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) site index of 36.6 m at a breast height age of 50 years (J.S. Wilson, by e-mail). The user's manual for ORGANON (Hann et al. 1997) recommends that the youngest age for running ORGANON should be 15 years at breast height for the SWO version and 10 years at breast height for the SMC version. For a site index of 36.6 meters, the corresponding total ages would be 23 years for the SWO-ORGANON (Hann and Scrivani 1987) and 17 years for SMC-ORGANON (Bruce 1981). Therefore, the authors' applications of the ORGANON model were extrapolations outside of the recommended age range.

(3) The authors did not state which edition of ORGANON was used in their analysis, but the signature date on J.S. Wilson's Ph.D. dissertation (the source of their article) was June 1, 1998. A "beta" test edition of SMC-ORGANON was released to the cooperators (including the University of Washington where J.S. Wilson took his Ph.D.) in January 1998, and the first general release of SMC-ORGANON was in May 1998. The authors, therefore, were using a very early, untested edition of

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SMC-ORGANON when conducing their analysis. There have been several significant revisions to SMC-ORGANON since June 1998 to correct problems and improve performance.

From my experience with answering questions on the ORGANON website and from running ORGANON training workshops, users too frequently introduce problems when they incorrectly apply a growth model in their analyses and (or) inaccurately or incompletely report results from the analyses. Therefore, I would like to suggest some guidelines for users to follow in the hope that these suggestions will help to reduce the type of problems I found in the Wilson and Oliver (2000) article.

(1) Thoroughly describe the input data sets used to run the model. The description should have enough details so that the reader could reproduce the reported results.

(2) Use realistic input data to run the growth model by collecting (rather than generating) the data in a manner that minimizes measurement errors due to rounding (e.g., Swindel and Bower 1972), estimation or approximation (e.g., Monserud 1976), or the use of alternative sampling-unit designs (e.g., Hann and Zumrawi 1991). For a model such as ORGANON, this translates into using a statistically sound sampling procedure (preferably the one described in Hann and Zumrawi 1991) to collect the following data on every sample tree: species, diameter at breast height measured to the nearest 0.1 in. (2.54 mm), total height measured to the nearest foot (30.48 cm), and height to crown base measured to the nearest foot. The necessity of measuring total height and height to crown base on every sample tree could be relaxed only if projections of average stand attributes are of interest and only if the stand has a simple structure. Even in these circumstances, however, the subsample for these two attributes should still be of substantial size.

(3) Read the literature describing the equations and other internal workings of the growth model to better understand the model's behavior and its strengths and weaknesses. For example, if the authors' had read the publications of Hann and Ritchie (1988) and Ritchie and Hann (1990) that describe the height growth rate equations in ORGANON, they would have known that their claim that "… growth models usually predict height growth based on the prediction of diameter growth …" (p. 916) was not true for ORGANON.

(4) Avoid extrapolating a model to populations for which it was not intended. If extrapolation is unavoidable, then clearly report that fact.

(5) Report the edition number, version number, or compilation date for the model used in the analysis. The development of growth models should be a dynamic process in which corrections and improvements are ongoing. As a result, problems identified with one edition may have been corrected in subsequent editions.

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