

Calibration and validation of the Forest Vegetation Simulator (FVS) using historical data for boreal species in Ontario

Valérie Lacerte¹, Guy R. Larocque¹, Murray Woods², W. John Parton³ and Margaret Penner⁴

¹Natural Resources Canada, Quebec, QC

²Ontario Ministry of Natural Resources, North Bay, ON

³Ontario Ministry of Natural Resources, South Porcupine, ON

⁴Forest Analysis Ltd, Huntsville, ON

Abstract

Historical data for the main conifer forest species in Ontario were used to derive new models for the Forest Vegetation Simulator (FVS) to predict dbh growth rate. The validation exercise indicated that the new models were biologically consistent for the prediction of individual-tree dbh growth rate.

Introduction

The Forest Vegetation Simulator (FVS) has a long history of development in North America to predict the effects of different types of silvicultural treatments on tree and stand growth. A recent validation effort of the Lake States variant of FVS (LS-FVS) for the Ontario forest conditions identified several weaknesses. For this reason, new models of dbh growth rate, survival rate, stem height and species group density index were calibrated using data from permanent sample plot data located in Ontario. The new models were validated with an independent dataset consisting of sample plot data located in Quebec. The dbh growth rate models for black spruce (*Picea mariana* (Mill.) B.S.P.), jack pine (*Pinus banksiana* Lamb.), balsam fir (*Abies balsamea* (L.) Mill.) and trembling aspen (*Populus tremuloides* Mill.) are presented.

The calibration dataset was characterized by wide variation in age, stand density and site index for most species (Table 1). Different model forms were tested. The majority of the new calibrated models included tree dbh, mean stand dbh, basal area and site index as independent variables. For the validation effort, the level of variation in age, stand density and site index in the Quebec dataset was also important.

Table 1: Basic characteristics of the data used to calibrate new models for black spruce, jack pine, balsam fir and trembling aspen.

Species	Mean		
	Age (year)	Stand density (stems ha ⁻¹)	Site index (m)
Black spruce	94	3508	13
Jack pine	79	2494	15
Balsam fir	92	2333	16
Trembling aspen	59	3420	18

Results and discussion

The new calibrated models derived to predict individual-tree dbh growth rate had similar forms (Table 2). All the parameters of the independent variables were statistically significant. The mean residuals of the new models were then computed and compared with the mean residuals of the species-specific models of the original version of LS-FVS using the Ontario dataset and the Quebec independent dataset (Table 3). For both datasets, the mean residuals computed with the new calibrated models were lower, except for balsam fir in the Quebec dataset.

Table 2: Model forms of the individual-tree dbh growth rate models (cm year⁻¹) derived for black spruce, jack pine, balsam fir and trembling aspen in Ontario.

Species	Dbh growth rate model (cm year ⁻¹)
Black spruce	$(\exp(\alpha_{dbh} \cdot dbh^{2+si^{0.9}} / (\exp(\alpha_{dbh} \cdot dbh / mdbh) + \alpha_{ba}))) - 1$
Jack pine	$(\exp(\alpha_{dbh} \cdot mdbh^{2+si^{0.9}} / (\exp(\alpha_{dbh} \cdot dbh))) - 1$
Balsam fir	$(\exp(\alpha_{ba} \cdot ba + \alpha_{dbh} \cdot dbh / (\exp(dbh \cdot ba)^{0.9})) - 1$
Trembling aspen	$(\exp((dbh \cdot ba)^{0.1} / (\exp(\alpha_{dbh} \cdot dbh / mdbh))) - 1$

Table 3: Comparison of the mean residuals of the new calibrated dbh growth rate models with the mean residuals of the original LS-FVS models using the Ontario and Quebec datasets.

Species	Mean	
	New calibrated model	Original FVS model
Ontario dataset		
Black spruce	-0.0823	-0.1292
Jack pine	0.0007	0.0021
Balsam fir	0.0085	-0.1774
Trembling aspen	-0.0779	-0.0942
Quebec dataset		
Black spruce	0.0128	-0.0210
Jack pine	0.0164	0.1534
Balsam fir	0.0721	0.0208
Trembling aspen	-0.0519	0.0586

The new calibrated model for black spruce was characterized by a consistent pattern of tree growth for different conditions of mean dbh, site index and basal area (Figure 1, a-c). Dbh growth rate increased with increase in mean dbh for a given basal area and site index. For the same site index, there was a pattern of decrease in dbh growth rate with increase in basal area. The behavior of the new calibrated models was more consistent and stable than that of the original LS-FVS models (Figure 1, d). Predicted dbh growth rate was characterized by fluctuations with change in dbh and negative values were obtained.

Acknowledgements

Sincere thanks are extended to the Ontario Ministry of Natural Resources, the Forestry Research Partnership, and the Direction des inventaires forestiers du ministère des Ressources naturelles et de la Faune du Québec.

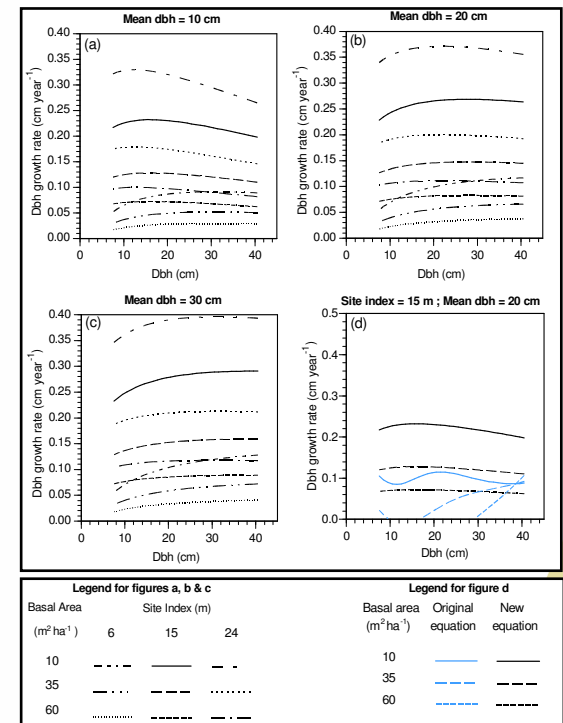


Figure 1: Predicted dbh growth rate for black spruce for different conditions of mean dbh, basal area and site index using the new calibrated model (a-c) and comparison of the original (LS-FVS) and new models (d).

Note: Some material in the tables and the figure are reprinted from Ecological Modelling, vol. 199. V. Lacerte, G.R. Larocque, M. Woods, W.J. Parton and M. Penner, Calibration of the forest vegetation simulator (FVS) model for the main forest species of Ontario, Canada. Pp. 336-349, Copyright (2006), with permission from Elsevier.