The Validation of the Mixedwood Growth Model (MGM)

Mike Bokalo, Ken Stadt, Phil Comeau and Steve Titus
Department of Renewable Resources, University of Alberta

Introduction to MGM

The Mixedwood Growth Model (MGM) is a deterministic, distance-independent, individual tree-based stand growth model for the western Canadian boreal forest. The model was developed to enable decision makers to explore potential growth and yield outcomes for a range of forest management practices.

MGM models growth of pure or mixed stands of four major boreal species: white spruce (Picea glauca) (SW), lodgepole pine (Pinus contorta var. latifolia) (PL), trembling aspen (Populus tremuloides Michx.) (AW), and black spruce (Picea mariana) (SB).

The model can be initialized using a tree list or stand table, including juvenile trees < 1.3m height. Alternatively a tree list can also be created using user provided stand summary data.

The required-model inputs are species, height, diameter at breast height (DBH) and either breast height age or total age for each tree, and an estimate of site index for each species.

Outputs summarize both tree and stand characteristics. Summaries are provided as yield tables and charts portraying averages and totals for the conifer and hardwood components including estimates of above ground tree biomass. Linkage to the Stand Visualisation System (SVS) is also built into the model, to render visual snapshots of the stand structure at any stage.

Examples of MGM outputs:

Validation of MGM

For MGM to be considered appropriate for operational use, it is necessary for forest management decision-making, it must be validated. We have recently completed a whole model validation. The objective of the validation was to evaluate all of the model components and their interactions as one system. This approach assesses the accuracy of the model by comparing model predictions to actual or observed data.

Methods:

Using permanent sample plots, tree-lists from the first plot measurement were used to initialize MGM and make projections to the final re-measurement where the observed stand conditions were evaluated against the MGM predictions.

Permanent Sample Plot Datasets:

- Alberta Sustainable Resource Development (ASRD)
- Mature PSPs (SRD)
- Stand Dynamics System Juvenile PSPs
- Western Boreal Growth and Yield Association juvenile PSPs
- Saskatchewan Ministry of the Environment mature PSPs

Plots were categorized by the dominant species:

- Pure types: white spruce (SW), trembling aspen (AW), lodgepole pine (PL)
- Mixed types: conifer leading (CD); deciduous leading (DC)
- or if too little data a general mixedwood category (MX)

Validation Variables:

- volume (m³/ha)
- basal area (m²/ha)
- average DBH (cm)
- top height (m)
- density (sph).

Validation Metrics:

- Scatter plots: observed vs. predicted
- Average Model Bias: $AMB = \frac{1}{n} \sum (Y_i - \bar{Y}_i)$
- Relative Model Bias: $RMB = \frac{1}{n} \sum \left(\frac{Y_i - \bar{Y}_i}{\bar{Y}_i}\right) \times 100$
- Efficiency: $EF = 1 - \frac{\sum (Y_i - \bar{Y})^2}{\sum (Y_i - \bar{Y})^2}$
- Paired t-test for Equivalence:

Where: $Y_i$ is the observed, $\bar{Y}_i$ is the predicted, $\bar{Y}$ is the average of the observed values and $n$ is the number of observations.

Examples of MGM outputs:

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Members of the MGM Strategic Development Team:

A Strategic Development Team representing Industry, the Provincial Government, and the University of Alberta was created to provide expertise in the development of MGM.

Members: Dr. Mike Bokalo – Project Leader, University of Alberta
Dr. Ken Stadt – University of Alberta
Dr. Phil Comeau – University of Alberta
Dr. Steve Titus – University of Alberta
Mr. Greg Bohunek – Western Boreal Growth and Yield Association (WESBOGY)
Mr. Gordon Whittome – Western Boreal Growth and Yield Association (WESBOGY)
Dr. Gino Grov – Mixedwood Management Association (MWMA)
Mr. Will Ford – Mixedwood Management Association (MWMA)
Dr. Ken Greenway – Alberta Sustainable Resource Development (SRD)
Dr. Yang Yang – Alberta Sustainable Resource Development (SRD)
Dr. Victor Lefebvre – University of Alberta

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Results:

Scatterplots observed vs. predicted volume (m³) for the conifer and deciduous component of the AW, SW, PL and CD species group, with their respective AMB, RMB and EF in statistics for the SRD dataset.

Conclusions:

MGM offers forest managers the opportunity to predict, at an individual tree and stand level, the future outcomes of many different species mixtures, stand structures and thinning or tending treatments. This whole model validation has put MGM through a rigorous evaluation process. The results of the validation show that the Mixedwood Growth Model (MGM) validates well for both pure and mixed species stands of aspen, spruce and lodgepole pine in Alberta. Some problems indicate the need for better representation of agents that cause sudden increases in mortality (insects, disease, climate), a need for some regional calibration, and a potential need for adjustment of some functions in order to better represent managed/tended stands.

Publication:


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Dr. Mike Bokalo
Department of Renewable Resources
University of Alberta
Phone: (780) 492-9038
Email: mike.bokalo@ualberta.ca