Refinement of the FVS-NE predictions of individual tree growth response to thinning

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- Regional growth model (Forest Vegetation Simulator; FVS) was updated and extended to the Acadian Forest

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http://www.nsrcforest.org

Project Summary

Regional forest growth and yield models like the Forest Vegetation Simulator (FVS) are designed to project future stand conditions under different management scenarios. However, the current version of the FVS for the Acadian Region is based on historic datasets and traditional statistical techniques, which may limit its accuracy. This project was initiated in 2008 to revise and refine FVS-NE predictions of individual tree growth, particularly in response to thinning. Consequently, an extensive regional network of permanent plot data was compiled and used to refit the primary components of FVS. These equations have been incorporated into a Open Source Model (OSM) software system being developed by Chris Hennigar of the University of New Brunswick. Overall, the model represents a significant improvement to the existing FVS model and will likely see wide application in the Acadian Region.

Background and Justification

- Growth models are widely used for forest planning
- FVS-NE shows significant bias in predictions (Figure 1)
- Bias can compound and strongly influence accuracy of long-term projections

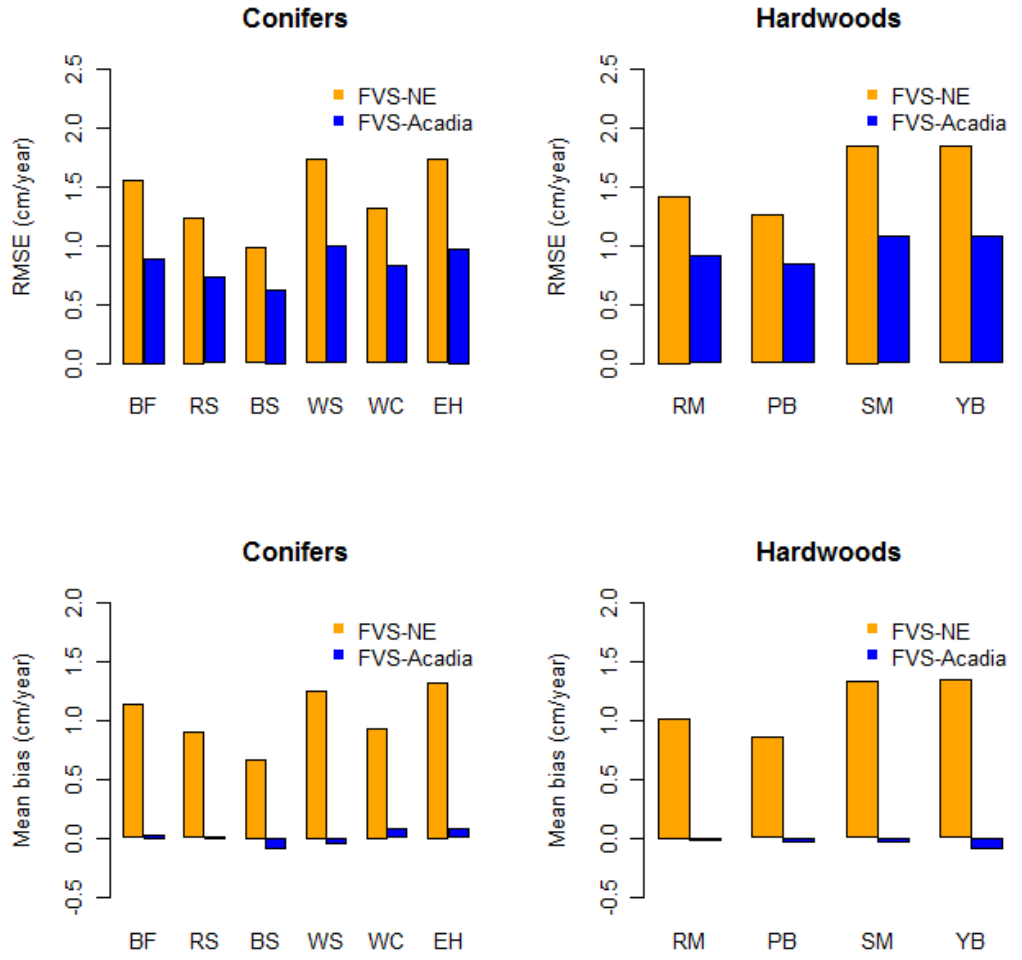


Figure 1. Mean root mean square (RMSE; cm yr^{-1}) and mean bias for FVS-NE and FVS-ACD by conifers and hardwood species for diameter increment.

Methods

- Compiled and cleaned a regional individual tree growth and yield database (Figure 2)
  - Over 4 million individual observations from 65 different species
- Range of stand conditions and silvicultural treatments
- Multiple remeasurements
  - 1955 to 2008

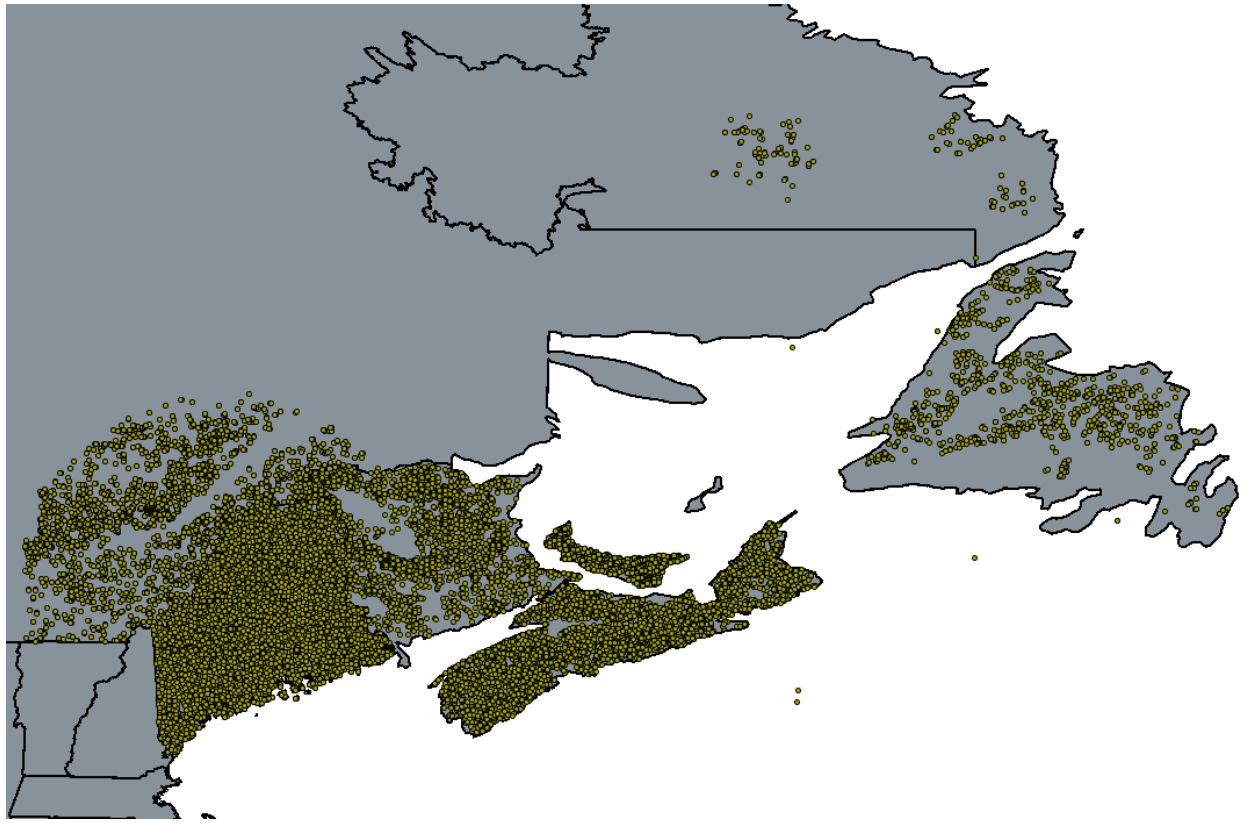


Figure 2. Location of permanent plots that were used in the construction of FVS-ACD

Methods

- Using compiled database, a variety of species-specific equations were developed (Tables 1)
- Nonlinear-mixed effects modeling used
- Equations evaluated and compared to existing FVS-NE equations

Table 1. List of component equations developed for the refined FVS-NE model and their associated reference.

Equation	Reference
Crown width	Russell and Weiskittel (2011)
Total tree height	Rijal et al. (2012a)
Height to crown base	Rijal et al. (2012b)
Diameter increment	Russell (2012)
Height increment	Russell (2012)
Crown recession	Russell (2012)
Mortality	Kershaw et al. (in prep)
Ingrowth	Li et al. (2011)
Stem taper	Li et al. (2012)

Results

- Developed a nonparametric regression model that relates climate to observed site index
  - Explained ~65% of variation using 5 variables
  - Model used to map site index at a 1 km^2 (Figure 3)
  - Can be used to forecast changes in future site index (e.g. Climate-FVS)

- Climate site index was a significant predictors in several component equations

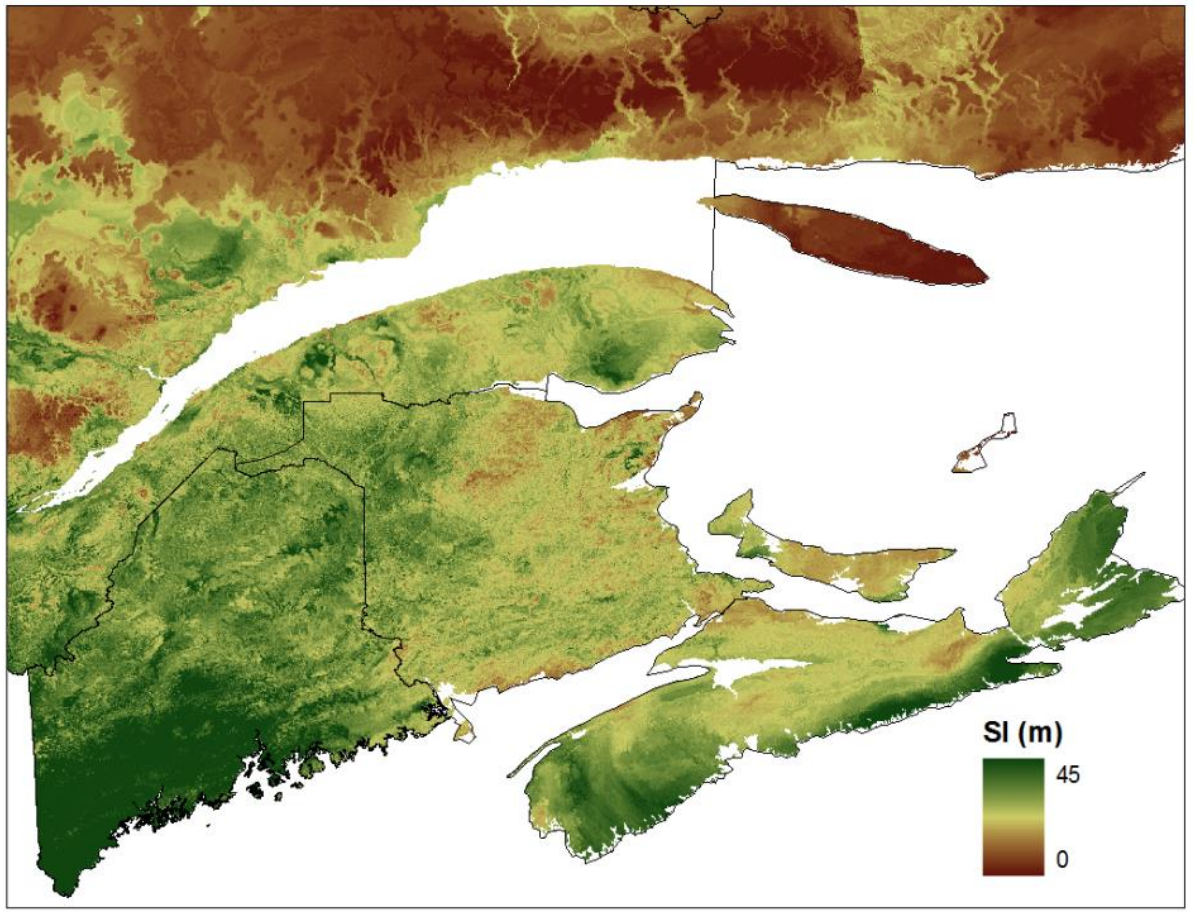


Figure 3. Map of predicted site index (m) derived from a 1 km raster of climatic variables.

Results

- Of all the component equations, the total height equations showed the highest bias
- Model form and covariates of component equations greatly modified when compared to FVS-NE
- Mortality equations diverged the most from the approach of FVS-NE

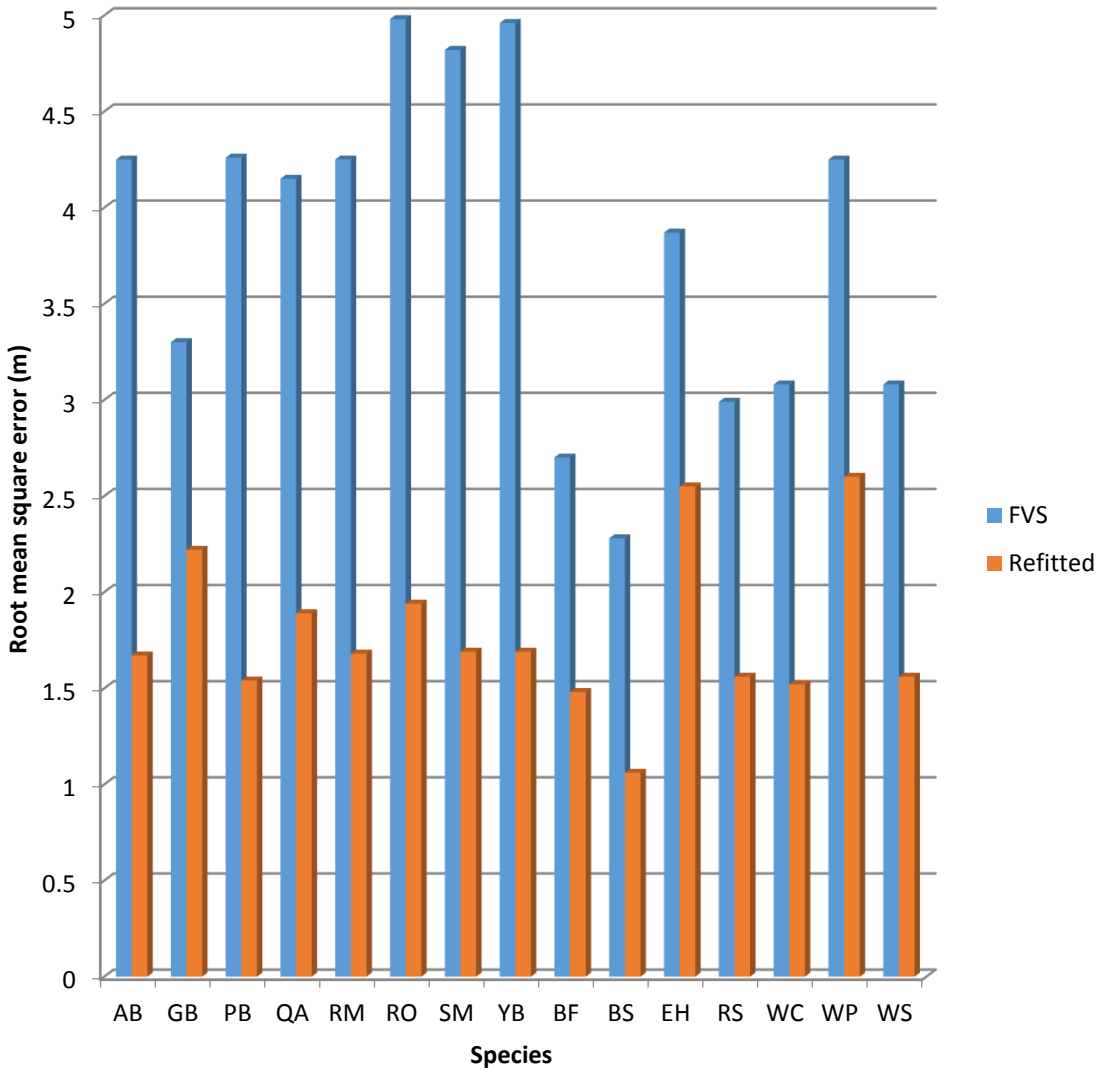
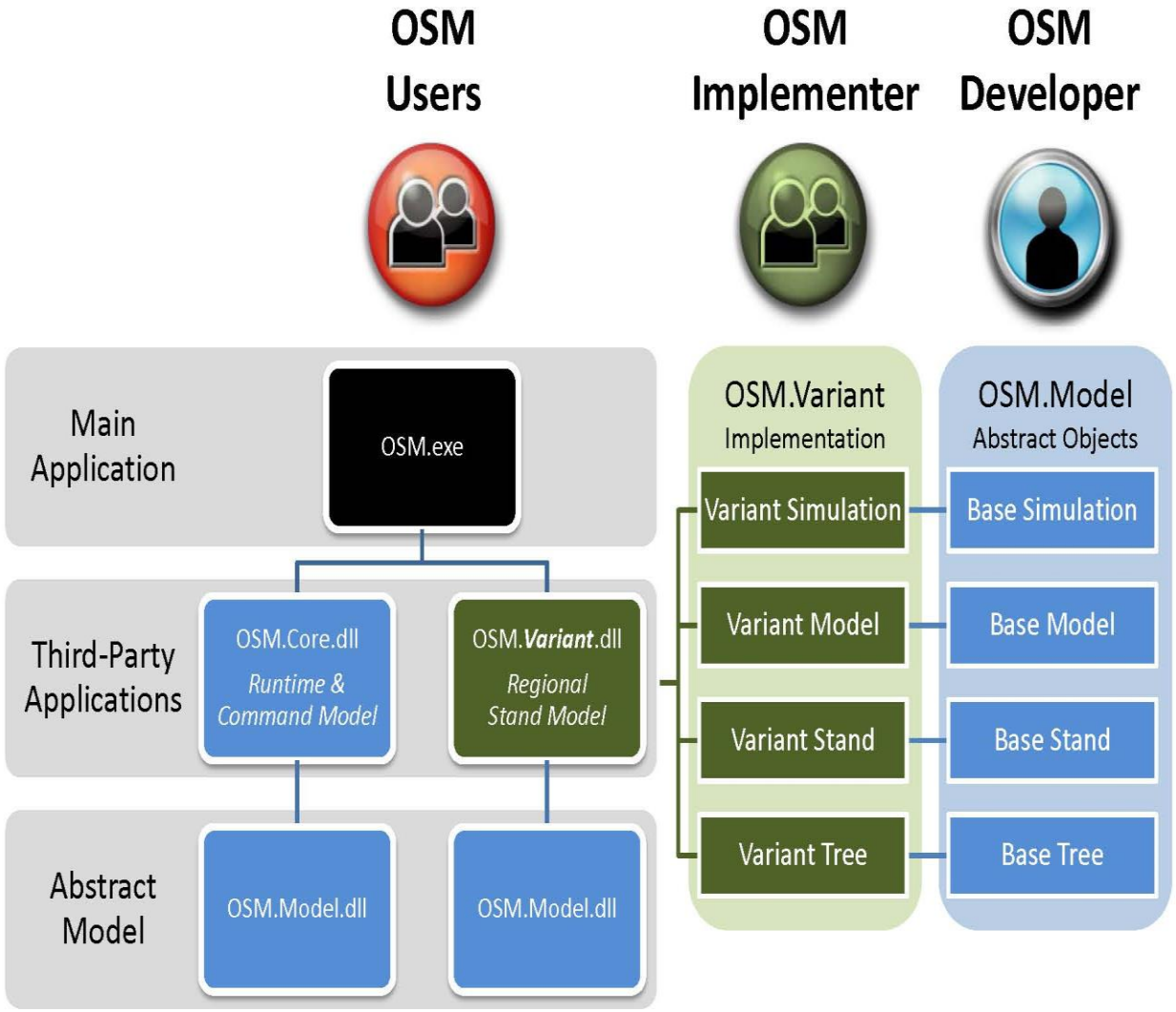


Figure 4. Root mean square error (RMSE; m) for the FVS and refitted total height equation by species.

Results

- Equations are being inserted into the Open Stand Model (OSM) of Dr. Chris Hennigar of the University of New Brunswick

- OSM is a very flexible interface that links with other third-party applications and provides batch mode processing



Implications and applications in the Northern Forest

- Model will be widely used to project future growth and yield under various scenarios and provide different results when compared to the original FVS-NE (Figure 4)
- Allow a better understanding of regional variation in growth and yield
- Improved forecasting ability and evaluation of the role of forest management

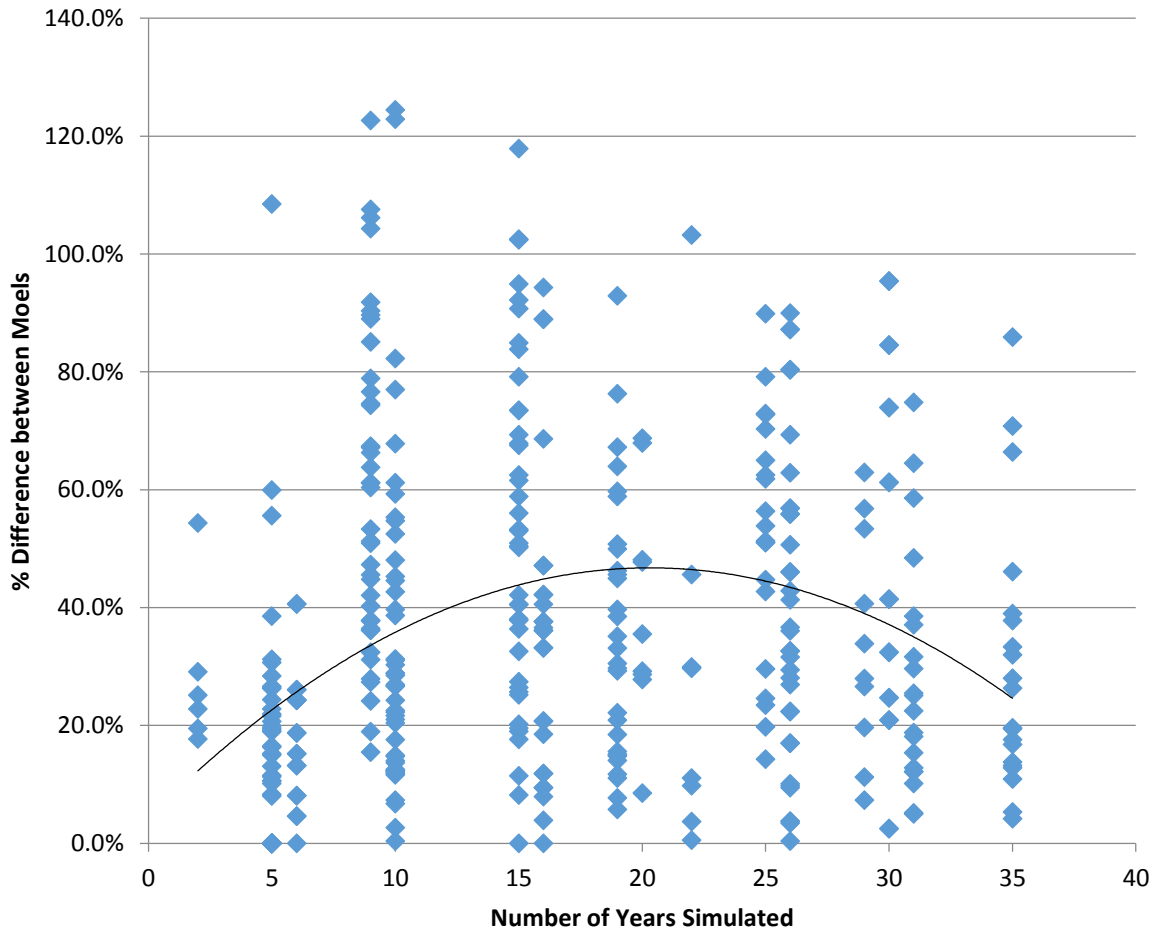


Figure 4. Percent different between FVS-NE and FVS-ACD projections of stand basal area over number of years simulated.

Future Directions

- Test and verify model predictions
- Improve FVS-ACD ability to represent various factors
  - Management (e.g. thinning, vegetation control, genetics)
  - Spruce budworm
  - Climate change
- Utilize model to forecast future regional wood supply and wildlife habitat

List of Products

- Li, R., Weiskittel, A.R., Kershaw Jr, J.A., 2011. Modeling annualized occurrence, frequency, and composition of ingrowth using mixed-effects zero inflated models and permanent plots in the Acadian Forest Region of North America. Canadian Journal of Forest Research 41, 2077-2089.
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- Rijal, B., Weiskittel, A.R., Kershaw Jr, J.A., 2012a. Development of regional height to diameter equations for fifteen tree species in the North American Acadian Region. Forestry 85, 379-390.
- Rijal, B., Weiskittel, A.R., Kershaw Jr, J.A., 2012. Development of height to crown base models for thirteen tree species of the North American Acadian Region. Forestry Chronicle 88, 60-73.
- Russell, M.B., 2012. Modeling individual tree and snag dynamics in the mixed-species Acadian forest. PhD Dissertation. University of Maine, Orono, ME, p. 215.
- Russell, M.B., Weiskittel, A.R., 2011. Maximum and stand-level crown width equations for the major tree species in the Acadian Region. Northern Journal of Applied Forestry 28, 84-91.