Validation results for the Utah and Western Sierra variants of the Forest Vegetation Simulator

Executive Summary

The Forest Vegetation Simulator (FVS) is a popular and widely used growth and yield model. Recent interest in assessing FVS model outputs led to the development of a validation protocol, which was used to guide the validation of the Utah and Western Sierra Variants of FVS. The approach involved four steps:

(1) **Data set description** - Forest Inventory and Analysis (FIA) data for Utah and California were used because they were the largest and most comprehensive data sets which also included diameter increment;
(2) **Verification** - involved running model simulations over time and comparing the results to well established principles of forest stand dynamics;
(3) **Validation** - involved quantifying bias in predictions of large tree diameter growth; and
(4) **Sensitivity analysis**, which quantified the rank and importance of independent variables in the large tree diameter growth model.

Verification results showed expected patterns of growth behavior over time for most species. Conformance to well-known patterns of, for example, height growth, volume increment, and self-thinning were evident in virtually all species of both the Utah and Western Sierra Variants. Potential issues associated with site quality for some woodland and hardwood species in the Utah Variant were identified. Volumes achieved by some species in the Western Sierra Variant were suspect but were not due to inherent model problems and could likely be remedied by volume equation modification. Simulation modeling performed using the Utah or Western Sierra Variants is likely to result in robust predictions of future conditions.

Validation results for the large tree diameter increment model revealed bias in growth predictions that varied by species and across diameter classes. In the Utah Variant aspen displayed the most bias, but this was primarily in the smaller size classes, whereas most of the coniferous species exhibited very little bias in diameter growth predictions. The Western Sierra Variant exhibited slightly more bias than the Utah Variant overall. With the exception of ponderosa pine, the largest bias occurred in the smaller size classes.

Sensitivity analysis results for the large tree diameter increment model showed that for most species diameter at breast height, site index, and crown ratio were the most influential predictors with a positive relationship to diameter increment. Similarly, predictors with a negative relationship to diameter increment were primarily associated with increasing stand density.

Specific recommendations for the Utah Variant include:

- Identify the problem associated with production being much higher on lower quality woodland sites than high quality sites
- Re-examine the limber pine large tree diameter increment model
- Re-examine the aspen large tree diameter increment model

- In future modeling efforts maintain the focus on incorporating the variables most highly influential on diameter increment predictions, for example, diameter at breast height, site index, and crown ratio

Specific recommendations for the Western Variant include:

- Re-examination of the red fir model for trees > 10 in. DBH
- Re-examination of the Jeffrey pine model for trees < 10 in. DBH
- Continued model development for an overall reduction in bias for the large tree diameter growth models
- Work with FIA to obtain diameter increment data for species that do not have diameter increment data, for example, Giant Sequoia

Summary and recommendations for FVS in general include:

- Using the FIA database for continued model fitting, and validation, as new data are added on an annual basis