Implementation of recommendations from ESSA report

During our recent State Forests Division (Division) planning process, stakeholders expressed concern regarding how the Division conducts modeling on State Forests. A Technical Expert Review Group (TERG) was formed to investigate and provide feedback on the modeling methodology used by the Division. The Division responded to feedback centered on growth and yield modeling by contracting with ESSA Technologies (ESSA) to provide technical recommendations. This document describes steps that the Division has taken to implement recommendations from the final report by ESSA Technologies. This implementation represents the latest step forward in the Divisions' continuous improvement of its forest inventory and growth and yield modeling processes. This work focused on districts managed under the Northwest Oregon State Forests Management Plan (NWFMP).

Selection of a Single Growth Model

To date, the State Forest Division has used two different growth models: the Forest Project System (FPS) which is integrated into the Stand Level Inventory (SLI) update process; and the Forest Vegetation Simulator (FVS) which the Division uses to project growth for forest modeling.

FPS has been used since the initial development of the Division's SLI (2001) to compile forest inventory measurement data and grow it forward to the current year. This is an annual process, and uses an older version of the FPS software that does not contain any calibrations specific to the lands managed by the State Forests Division.

FVS has been used since the Harvest and Habitat modeling project (completed in 2006) to create growth and yield projections for long range planning efforts. The Division has implemented certain calibrations to FVS over the years to better reflect conditions on lands managed by the State Forests Division.

The use of two different models has created confusion among stakeholders. A common recommendation of the TERG members was to select a single growth model for both purposes. The Division has selected FVS as its growth model going forward. FVS outputs will be used to populate the annual SLI update, as well as yield tables for long-range planning.

Implementation of specific recommendations

Within the context of the State Forests Division's selection of FVS, the Division contracted with ESSA for technical assistance pertaining to specific aspects of growth and yield modeling. State Forests Division staff is implementing recommendations from ESSA's report.

Specifically, calibrations will be implemented for factors affecting growth rates, mortality and volume estimation. Growth rate calibrations include site index estimation and basal area growth multipliers; mortality calibrations include maximum stand density index, and use of recently revised mortality functions in FVS; and volume estimation includes standardizing procedures for estimating cubic foot volume and merchandized volume (Scribner board foot).

Measured stands will be grown forward from their inventory date to 2016 (i.e., through the 2015 growing season to coincide with the SLI revision cycle). Some stands have not been measured in over 10 years. Non-measured stands will be imputed to grow forward inventory data. Imputation assumes target (un-measured) and source (measured) stands are most similar as of the report year. This will result in a new current inventory estimate.

Projected growth (i.e., beyond the current year) will predict growth of each stand individually using unique site characteristics.

Implementation Details

The following describes the key factors that the Division is implementing based on the ESSA recommendations.

Site Index (SI)

ESSA Recommendation: Use site tree sample data rather than soils data.

The Division Implemented the ESSA Recommendation: New stand level SI models have been derived using site tree sample data from SLI cruises. Previously, SI values were derived from soils data when projecting growth for planning purposes.

Predicted SI will be used for stands without sample data and for modeling future regeneration stands. The SI models use Random Forests (regression mode), a machine learning technique. Other methods were evaluated (multiple linear regression, spatial auto regression) but Random Forests provided robust results with few complications. Predictor variables for SI include topographic, climatic, soils, and location attributes. This work was extended to districts outside the NWFMP.

Sufficient site tree sample data are available to fit models for Douglas-fir, western hemlock, red alder, ponderosa pine, white fir, and lodgepole pine.

Basal Area Growth Calibration

ESSA Recommendation: ODF's practice of applying district specific growth modifiers is appropriate. These modifiers should be recalculated using the new SI. New radial increment core data should be collected to update data last collected from permanent plots in 2001.

The Division Implemented the ESSA Recommendation: District-level average basal area growth multipliers will be assessed from the permanent plot radial increment core data.

For Douglas-fir on the Tillamook District, basal area growth multipliers will be determined using growth data collected and analyzed in cooperation with the Swiss Needle Cast Cooperative.

Maximum Stand Density Index (SDI)

Maximum SDI is a key term in the FVS model to ensure modeled stands do not grow beyond a realistic density. As a projected stand grows to a certain density, mortality functions "kill" certain trees to keep the stand at or below the maximum SDI. FVS can accommodate maximum

SDI values for many species and includes procedures for integrating SDI for mixed species stands.

ESSA Recommendation: SDI should be reassessed for key species using nearly pure species stands. Use the current version of FVS, which includes a revised mortality function for northwest Oregon (NWO variant) that is adapted from the Organon growth model.

The Division Implemented the ESSA Recommendation: Maximum SDI was estimated for key species by evaluating nearly pure stands of that species in the SLI inventory. The 97th percentile of these stands was used as the maximum SDI.

Implementation of the revised mortality versus the previous version of FVS mortality produced the largest difference in inventory volume estimates, as compared to the other calibrations. This difference was specifically addressed during the field review of inventory results, described below. Results of the field review indicate that the NWO mortality function may not reflect local conditions as well as the previous version of FVS (PN mortality function) on a significant portion of the lands managed by the Division in the north Coast Range.

ODF will implement the PN mortality function for Astoria and Tillamook Districts, and implement the NWO mortality function for all other districts.

Volume

ESSA Recommendation: Select volume estimation routines to standardize outputs for Scribner board foot product descriptions. Integrate cubic volume to better report volume for long-range planning and change comparisons.

The Division Implemented the ESSA Recommendation: Volume will be estimated using the Flewelling two point taper functions for Douglas-fir, western redcedar, and western hemlock in the Northwest Oregon Area. The Behre's hyperbola taper functions will be used for all other species and districts.

Standing volume will be reported two ways: 1) cubic foot units for change comparisons and long range planning functions, and 2) Scribner board foot merchandized volume for estimation of timber product. Merchandized volumes will assume:

- 40' log length and 5" diameter top for conifer species
- 32' log length and 6" diameter top for hardwood species

Field Review

The Division worked with ESSA to determine a methodology for field review of the revised growth and yield results.

Field staff were provided with estimates from the current revision of SLI (FPS), FVS (PN mortality function) and FVS (NWO mortality function), and were asked to select the estimate that most closely represented the actual stand. The sample consisted of 75 stands per district, and

was randomized and “blinded” so that reviewers did not know which modeling method was used. Five districts were able to provide review, using data such as harvested volume and market cruise data from nearby stands of similar type, and tree height measurements from lidar. For three districts there was no clear distinction among the three methods, suggesting that the NWO mortality function can be used. Two districts, Tillamook and Astoria, had a statistically significant selection preference for stands grown forward with the PN mortality function. The location of these districts on the north coast may indicate that the range of data used to develop the NWO mortality model does not represent that landscape well.

In light of the field review, the Division will implement the PN mortality function for the Astoria and Tillamook districts, and the NWO mortality function for all other districts.