Northwest Forest Plan (NWFP) Interagency Regional Monitoring, 15 Year Report
Status and Trend of Late-Successional and Old-Growth Forests

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Background and New Science

***Objective**:* Late-successional and old growth (LSOG) monitoring characterizes the status and trend of older forests to answer questions such as: How much older forest is there? Where is it? How much has it changed and from what causes? Is implementation of the Northwest Forest Plan (NWFP) maintaining or restoring older forest ecosystems to desired conditions on federal lands?

***Methods**:* We used satellite imagery, forest plot data, and statistical mapping techniques to develop maps of forest composition and structure at the two monitoring cycle endpoints ('bookend' maps), and yearly maps of forest disturbance. From the two bookend maps we assessed changes in the amount and distribution of LSOG (defined as average diameter of overstory conifers $\geq$20 inches and conifer canopy cover $\geq$10 percent) over the period. We used the disturbance maps to characterize the agents of change (timber harvest, wildfire, or insects/disease) in areas mapped as LSOG loss from the bookend map analysis. To corroborate the mapped information, we estimated LSOG area from two successive forest inventories where data were available (FS lands in Washington and Oregon and Oregon BLM lands), and compiled the first NWFP-wide estimates of LSOG on all ownerships from a regionally consistent inventory design using the most recent Forest Inventory and Analysis (FIA) data.

***New science**:* The vegetation mapping for NWFP monitoring marks the first application of gradient nearest neighbor imputation (GNN) to multiple imagery dates, allowing us to map the 'bookends' of the monitoring period. Previously, we had only a baseline map (1994/96), but no updated 'bookend 2' map and therefore no method for evaluating net change. The new approach represents a step forward in monitoring protocols, made possible by image normalization routines developed for Landsat-based detection of trends in disturbance and recovery (LandTrendr). Additionally, LandTrendr disturbance mapping provides better temporal resolution (annual time-series instead of every four or five years), and greater sensitivity to partial disturbances such as thinning and low-severity wildfire. Previously, we mapped only stand-replacing disturbances such as regeneration timber harvests or high-severity wildfires. The other significant improvement is that both mapping methods have been applied consistently across the entire NWFP area. Previously, we had different mapping projects in Region 5 and Region 6, and data incompatibilities limited our confidence in some of the monitoring results.

Key Results

- Bookend maps suggested a net loss (-1.9 percent) of LSOG in the NWFP area, from 33.2 percent (7.3 million acres) of federal forest in 1994/1996 to 32.6 percent (7.1 million acres) in 2006/2007. Net changes were small relative to the sources of error and uncertainty in the estimates.
- Strong evidence suggests that >200,000 ac of LSOG were lost to stand-replacing disturbance (mostly wildfire) on federal lands. Almost 90 percent of the loss of federal LSOG was from reserves.
- Some of the losses apparently were offset by recruitment, either through incremental stand growth or from understory disturbances that eliminated smaller-diameter trees and increased average stand diameter, but recruitment is much more difficult to estimate with available data and technology. A more restrictive definition of LSOG (larger average tree size and/or denser canopy) likely would increase the estimate of LSOG loss and decrease the estimate of LSOG gain.
- The small net decrease in LSOG was corroborated by successive forest inventories where available, but the plot-based estimates of LSOG change were not statistically significant.
- On federal lands, the biggest change in forest diameter class distributions was an increase in the 10-19.9-inch class, representing potential future recruitment into the LSOG class.

The results support assumptions made in the NWFP that the primary role in maintaining or restoring LSOG and related habitats would fall to federal lands. Federal lands contain less than half of the total forest land, but the federal share of total LSOG increased from 65 to 67 percent over the monitoring period. Wildfire was the most significant change agent for LSOG on federal lands and will continue to be a key consideration for policies affecting older forests, associated species, and watershed conditions.

Next Steps and Recommendations

The LandTrendr/GNN protocols were successfully applied to produce the data required for monitoring—not only LSOG, but also habitat for northern spotted owls, marbled murrelets, and potentially many other species. The data also have been used as the vegetation component for watershed condition monitoring. We recommend continuing the ongoing program of research and mapping technology in partnership with the Pacific Northwest Research Station and Oregon State University. This is consistent with an adaptive management framework that integrates the continuum of research and development, map production, technology transfer, and support. It will maintain continuity of mapping operations and ensure the updating of vegetation data on a regular cycle, which is essential for monitoring forest vegetation and species habitat status and trends. We recommend the following:

- Future analyses encompass a holistic view of forest structure and dynamics through application of a more ecological definition of LSOG.
- Revise our estimate of future trends in LSOG using inventory plots, growth and succession models, ecologically-based definitions, and assumptions about forest disturbance regimes.
- Begin exploring the inclusion of LiDAR-derived variables in our vegetation mapping process.

Figure 1. NWFP-wide map of LSOG (2006/07).

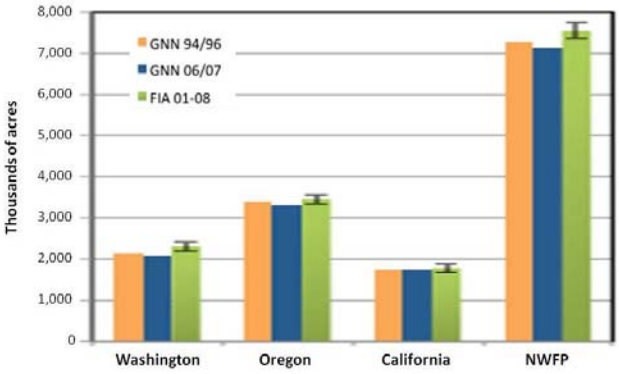

Figure 2. Area of LSOG from GNN bookend maps and from FIA Annual Inventory plots measured between 2001 and 2008. FIA estimates show +/- the standard area of the estimate.

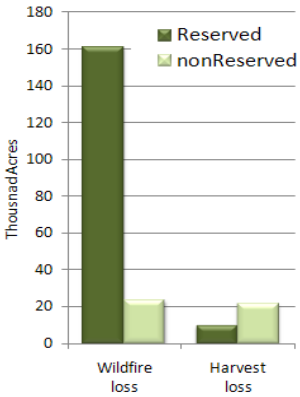

Figure 1. Disturbance agent attributed by LandTrendr to GNN-based LSOG losses.