Fire, Salvage, Forest History, and Topographic Effects on Large Dead Wood in an Oregon Landscape: The Importance of Legacy Wood

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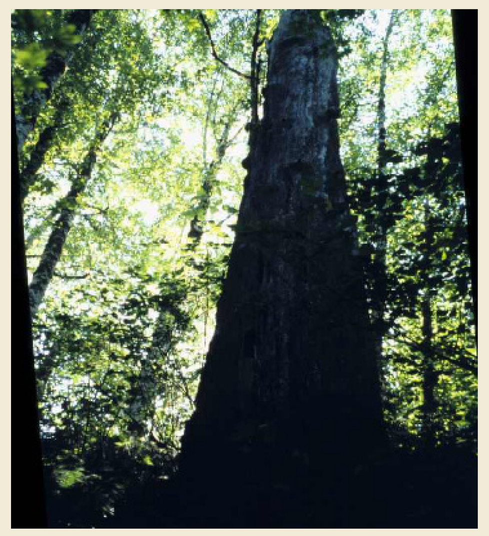
INTRODUCTION



Large legacy conifer snag in a red alder dominated lower slope forest

Determining the spatial pattern and abundance of large snags and logs, and their underlying mechanisms, plays a significant role in our management of carbon sequestration and the habitats of the region's native flora and fauna. Patterns of fire and forest history, post-fire timber salvage, and topography can be important drivers of the fine- to mid-scale spatial distribution and abundance of large dead wood in forest ecosystems. The effects of history and topography on dead wood patterns in forested landscapes have not previously been examined. We hypothesized that in a disturbance regime dominated by fire, variation in large (>30 cm) dead wood could be explained by pre-fire forest condition, post-fire salvage intensity, and topography.

OBJECTIVES

(1) Determine how topography is related to the spatial distribution and abundance of large snags and logs

(2) Estimate the contribution of legacy wood (originating from the past stand) to the total dead wood pool

(3) Assess pre-fire forest conditions, in trees per acre and basal area, based on legacy stump and snag populations, to establish a reference point for observed snag and log abundances

(4) Characterize the spatial extent and amount of post-fire timber salvage and snag felling

METHODS

Fig. 1. The study area. Tillamook State Forest, northwestern Oregon

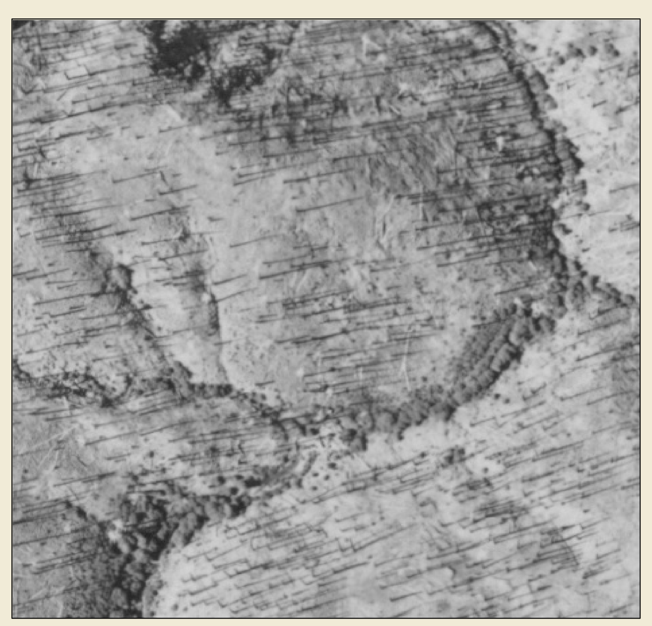


Fig. 2. 1954 aerial photograph of twice-burned, previously forested area in Tillamook State Forest prior to salvage. Visible lines are shadows of snags.

The Tillamook State Forest is located in the Coast Range mountains of northwestern Oregon (Fig. 1) . Multiple catastrophic wildfires occurred there from the 1929 to 1951 (Figs. 2 and 3). Terrain is rugged and steep, with a dense network of streams and a climate with warm wet winters and cool dry summers. Dominant tree species include Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and Sitka spruce (*Picea sitchensis*), with areas of red alder (*Alnus rubra*) and bigleaf maple (*Acer macrophyllum*).

We sampled three classes of dead wood: logs, snags, and legacy stumps, at 40 plots along a topographic gradient and according to fire history (Fig. 3) in a random stratified design.

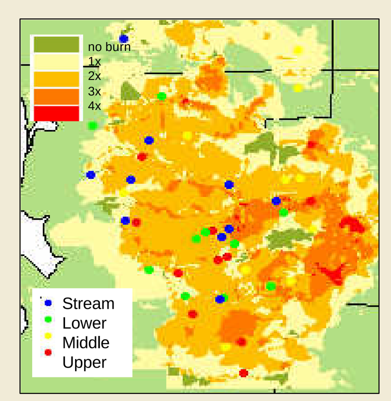


Fig. 3. Plot locations according to topographic position and fire frequency

Slope-corrected transects followed the slope contour. We used a 250 m line transect (150 m + 4 x 25 m) transects for logs, and a 10 x 150 m belt transect centered on the line transect for snags and stumps (Fig. 4).

Fig. 4. Transect layout. 250 m line (black; logs) and 1500m2 belt (orange; snags and stumps)

We collected data for diameter, height (snags and stumps), length (logs), species, decay class, legacy status, presence and number in in-stream jam (logs), and transect location.

Basal area measures of legacy stumps and snags and of current live trees indicated the natural propensity for large dead wood production.

A historical aerial photograph chronosequence (1954 -1970) provided post-fire snag felling and log removal data.

KEY FINDINGS

Human activities altered the dead wood production potential for the landscape by removing dead wood.

All plots were salvaged after fire. Snag felling and post-fire log salvage occurred at moderate to high levels throughout the area, leaving residuals at very low to low levels (Fig. 5).

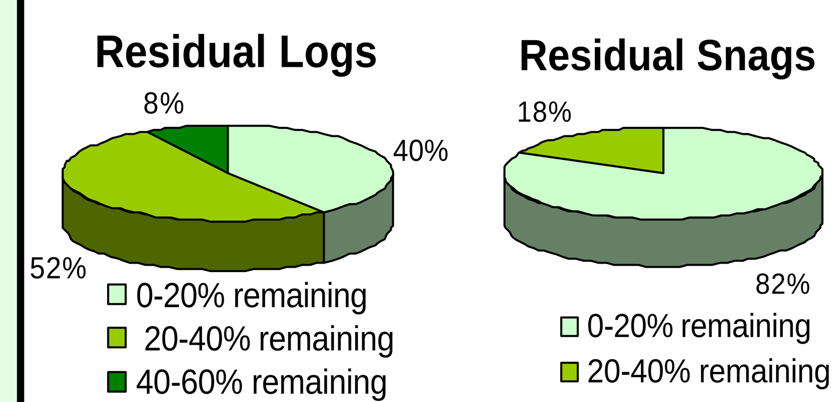


Fig. 5. Residual log and snag density after post-fire salvage

Most dead wood was legacy wood.

Legacy conifer logs were 81% of all dead wood volume and 89% of density per ha (Fig. 6). Biomass and carbon patterns were similar.

Snags from the current stand were just 18% of total snag volume.

Average carbon was 45.7 MgC/ha (s.e. 6.9), far below old-growth forest levels. Average biomass was 87.8 Mg/ha (s.e. 13.3).

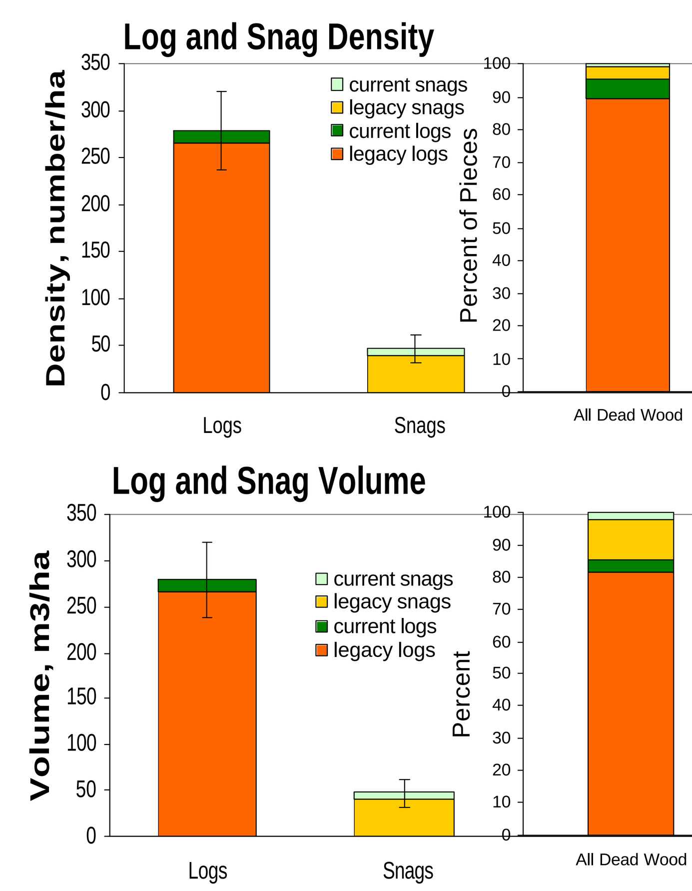


Fig. 6. Legacy and current dead wood density and volume

Large legacy conifer log with cut ends in a young coniferous forest. The log was felled during salvage after catastrophic wildfire.

Even after dead wood contributions of legacy and current stands were normalized by the basal area of the respective forest, legacy forest stands contributed much more dead wood to the total dead wood pool than current stands (Fig. 7 a).

As expected, basal area of and dead wood volumes produced by the current stands were much lower than those of the legacy stumps and snags in the pre-fire stand (mean 30.0 m2/ha, (se 1.4) vs 56.3 m2/ha (se 5.3)) (Fig. 7 b).

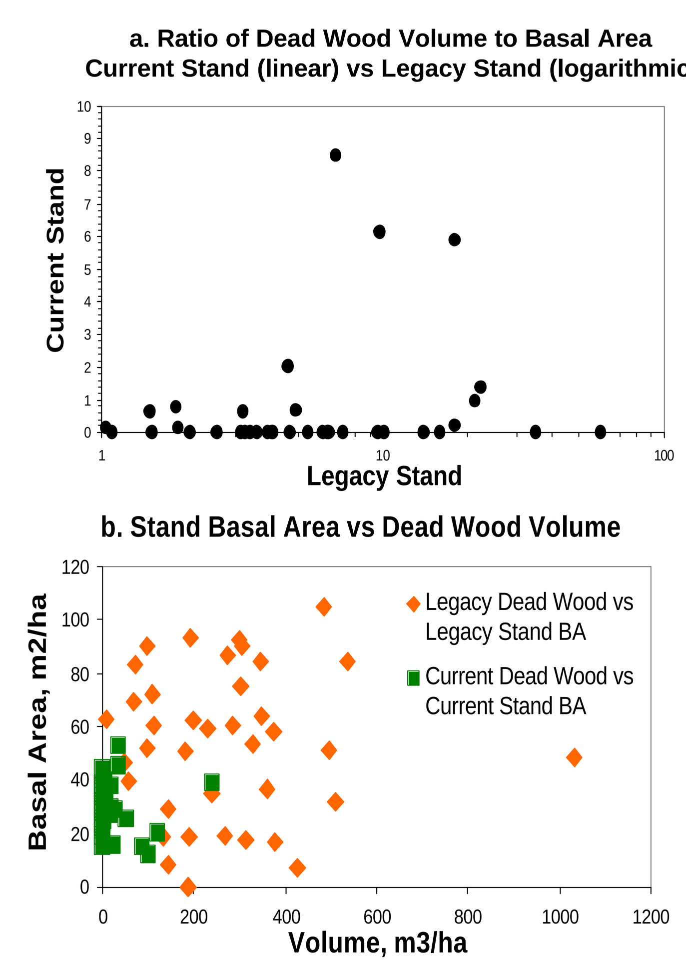


Fig. 7. Stand Basal Area – dead wood volume relationships

Most dead wood occurred near streams.

Variation within topographic position of dead wood was large (Fig. 8) but trends were observed.

Higher log densities, volume, biomass, and carbon occurred in streams than at all other topographic positions, and at middle slope than at upper slopes ($p<0.05$; t-tests).

Legacy snags were less abundant at middle than at upper or stream positions ($p<0.05$; t-tests); else, snag characteristics did not differ according to topography.

Upper slopes were source areas for dead wood.

Legacy stump and snag basal areas were greatest at upper slopes (Fig. 9), indicating migration of logs down from upper slope positions. This likely occurred via a combination of salvage activities and natural processes.

Most log volume currently occurs in streams, but upper slopes served as source areas for the greatest proportion of log volume.

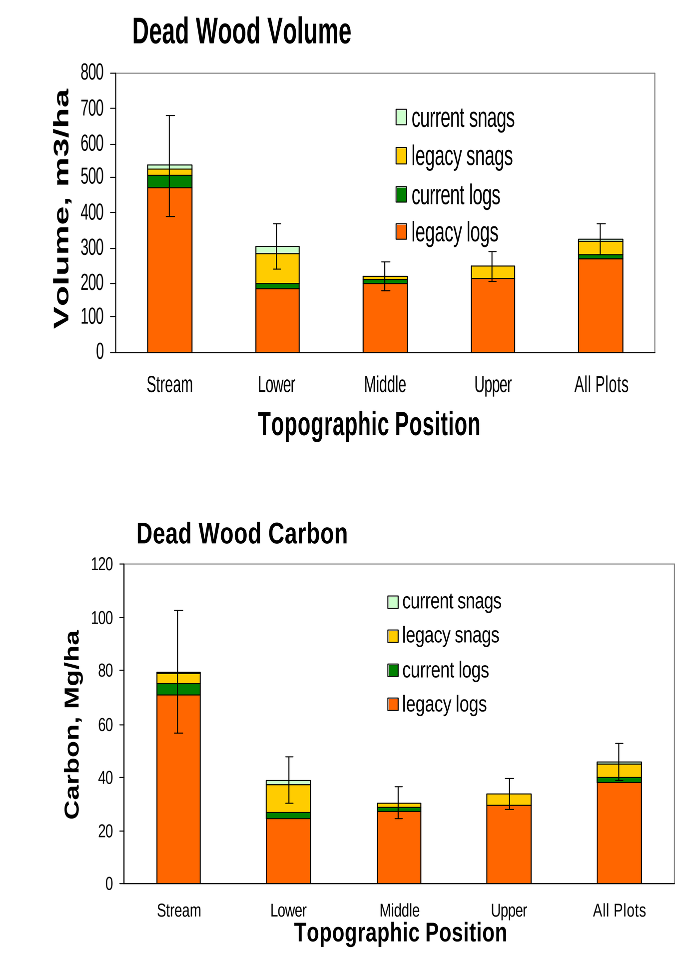


Fig. 8. Dead wood volume and carbon distribution by topographic position

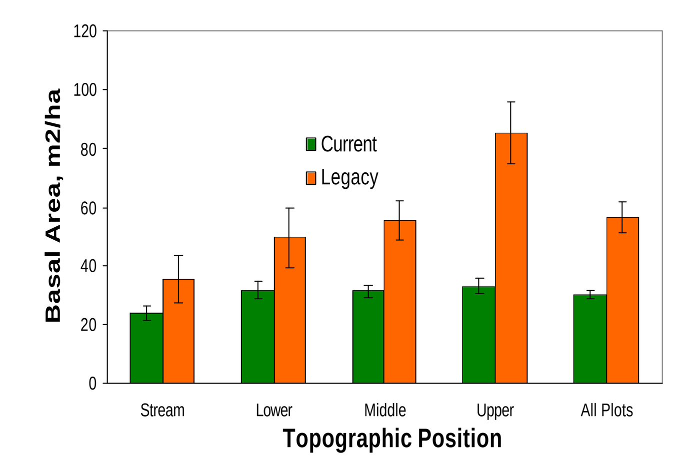


Fig. 9. Basal area of current stand and of legacy snags and stumps

FURTHER RESEARCH

- Characterize variability and patterns of dead wood across other landscapes according to related processes in the Coast Range
- Combine our topography and history-rich data for landscapes with a collection of regional dead wood datasets to produce an integrated, multi-scale assessment and a scale-sensitive model of dead wood dynamics.