Seasonal changes in live branch moisture content of three forest species in the Pacific Northwest

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Introduction

Forest harvest residues are an available resource that in many cases are being burned for site preparation and are seen as a green alternative for energy production. However, one of the biggest challenges for this material to be economically competitive with traditional fuel sources in the United States is its high transportation cost. Transportation cost is significantly affected by residue moisture content. As forest biomass moisture increases, transportation becomes more inefficient and expensive. Wood moisture can be reduced in the forest through drying. Drying rates will depend on several factors such as residue initial moisture content, climate conditions, species, and storage form. Residues are composed of tree tops, chunks, small diameter trees and branches. Branches are an important component, especially when pulp market prices are high and the larger biomass components are collected for pulpwood and are not available for energy wood. The initial step to understanding the drying process is to determine moisture content of the material when it is fresh and whether there are seasonal differences that can affect decision making.

Objectives

Literature is not consistent with regards to seasonal wood moisture content changes and moisture content of harvest residues at-time-of-harvest are not found for commercially relevant Pacific Northwest tree species. For that reason, the main objectives of this study are:

a) Determine seasonal average moisture content for live branches for the three main commercially relevant Pacific Northwest tree species.

b) Determine whether these average moisture contents are statistically different between seasons.

c) Determine the effect of branch height and heartwood in moisture content.

Study areas

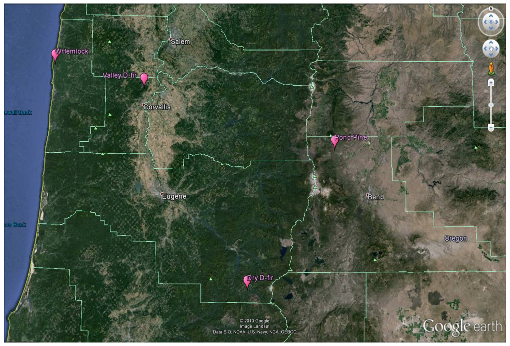

FIGURE 1 – Branch sampling locations. Map: Oregon. Google Earth, March 10, 2014.

Data collection and methodology

- Twelve trees were sampled on each site (Table 1). They were systematically selected every 24 m following a bearing. Trees were divided into two transects to fit the unit shape.

Site description	Location	Elevation (m)	Rain (mm)	Coordinates
Willamette Valley Douglas-fir	Corvallis, OR	283	1,092	44°39'29.13"N, 123°15'40.30"W
Higher elevation Douglas-fir	Oakridge, OR	871	1,154	43°30'17.80"N, 122°21'04.91"W
Ponderosa pine	Sisters, OR	1,003	330	44°18'37.75"N, 121°36'05.43"W
Western hemlock	Newport, OR	201	1,778	44°47'09.42"N, 124°03'04.67"W

TABLE 1 – Study site description

- Each tree was climbed once per season and one branch was randomly selected and cut at each canopy height level of the tree.

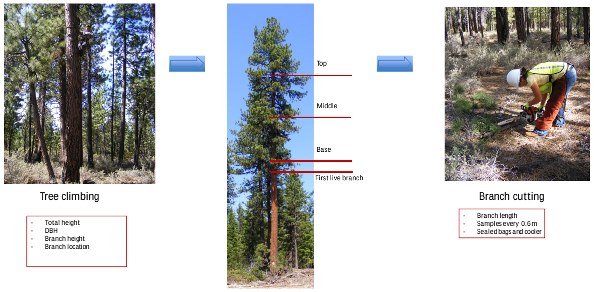

FIGURE 2 – Branch sample collection procedure for initial moisture content determination.

- Once branches were cut, branch length and height were recorded. A sample was obtained every 0.6 m in length and immediately stored in a sealed bag inside a cooler. Sample weight, diameter, heartwood content was determined in the lab, and then oven dried for moisture content determination.

- Statistical analysis: One-way Anova was used to establish differences in species average moisture content and One-way repeated measures Anova to establish differences in seasonal average moisture content. Bonferroni correction was applied to correct for the number of comparisons. In order to assess branch height and heartwood diameter effect on mean moisture content, two-way Anovas were performed. All the analyses were performed using R except for the contrasts performed in SPSS.

Results

- When branch average moisture content is examined by season, the lowest moisture contents occur during summer (0.43, wet basis) and highest during fall or winter (0.50, wet basis) depending on the species (Table 2).

Site	Fall	Winter	Spring	Summer
W. Valley Douglas-fir	0.46 ± 0.01	0.45 ± 0.01	0.46 ± 0.01	0.43 ± 0.01
Ponderosa pine	0.47 ± 0.01	0.50 ± 0.01	0.45 ± 0.01	0.43 ± 0.01
Western hemlock	0.47 ± 0.01	0.48 ± 0.01	0.48 ± 0.01	0.47 ± 0.01
Higher elevation Douglas-fir	0.46 ± 0.01	0.48 ± 0.01	0.47 ± 0.01	0.47 ± 0.01

TABLE 2 – 95% confidence intervals for weighted average seasonal branch moisture content (wet basis) by site

- When the branch moisture content is compared between seasons, W. Valley Douglas-fir and ponderosa pine have statistically significant differences between summer and all other seasons, being the lowest moisture content in the year (Figure 3).

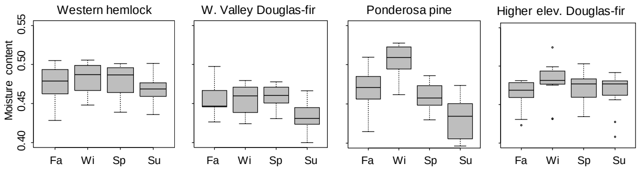

FIGURE 3 – Average branch moisture content by season.

- Both branch height and heartwood diameter have statistically significant effect on average branch moisture content. Branch height and heartwood explain more than 75% of the average branch moisture content, heartwood having the highest correlation. Specific equations were fitted for each species.

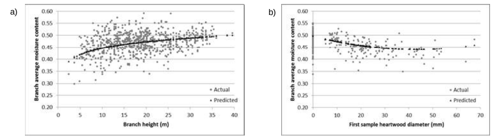

FIGURE 4 – Fitted regressions to predict branch average moisture content from a) branch height and b) heartwood diameter (first sample)

Conclusions

- Seasonal branch moisture content has been determined for the four major productive forests growing in the Pacific Northwest. This information is valuable to determine the starting moisture content of forest harvest residues prior to their in-forest storage. The highest average moisture content was 0.50 ± 0.01 in ponderosa pine during the winter.

- Average branch moisture content is significantly lower between summer and every other season in W. Valley Douglas-fir and ponderosa pine only.

- Branch height and heartwood diameter have strong correlation with branch average moisture content and therefore can be reasonably used as predictors.

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