The effect of decomposition on coarse woody debris combustion: a preliminary investigation

Joshua Hyde[1], A.M.S. Smith[2], Roger Ottmar[3], Penny Morgan[4], Ronald Robberecht[5]

[1]Department of Forest Resources, University of Idaho, Moscow, ID, USA. [2]Department of Forest Resources, University of Idaho, Moscow, ID, USA. [3]USDA Forest Service, Pacific Wildland Fire Sciences Lab, Seattle WA, USA. [4]Department of Forest Resources, University of Idaho, Moscow, ID, USA [5]Department of Rangeland Ecology, University of Idaho, Moscow, ID, USA.

Introduction

Coarse woody debris (CWD) are important for physical protection of the soil and plants (Graham et al. 1994), cover and den sites for wildlife (Bull 2002; Maser, Anderson *et al.* 1979), and carbon sequestration (Davis, Allen *et al.* 2003). During their combustion CWD can emit large quantities of pollutants which can affect regional air quality (Bertschi, Yokelson *et al.* 2003). Currently our ability to predict consumption of CWD, especially decayed CWD, is limited. We examined the consumption of CWD in varying states of decay.

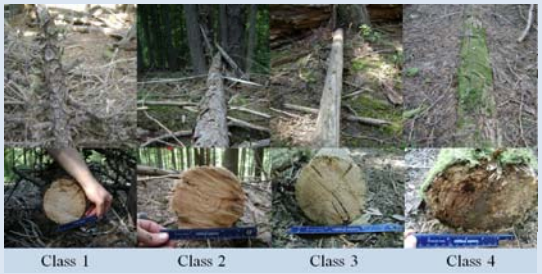
Objectives

- Evaluate the potential of using a common decay classification system in determining consumption of CWD in various states of decay.
- Document the properties that change with decay in relation to the consumption of these fuels.

Methods

Sections of mixed conifer CWD were removed from Priest River Experimental Forest in northern Idaho. For each section the decay was assessed on a scale of one to four using the system described by Maser *et al.* 1979. These samples were ignited using a propane heater and allowed to smolder until combustion ceased. Percent mass loss was recorded and compared among classes using an analysis of variance. Fuel properties were selected based on a review by Hyde et al. (In review) and were compared with consumption. These included:

- C:N Ratio
- Heat of combustion
- Percent moisture content
- Density
- Lignin content
- Surface area to volume Ratio



Representative examples of each decay class

Harvesting samples

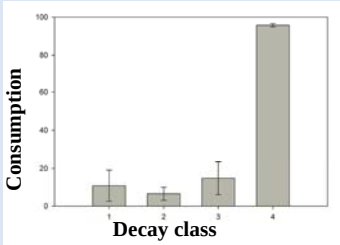
Igniting samples

Ignited samples smoldering

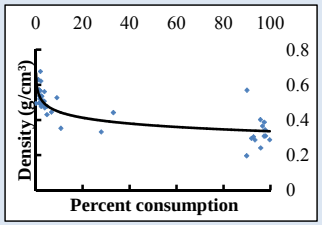
Burning sample

Results

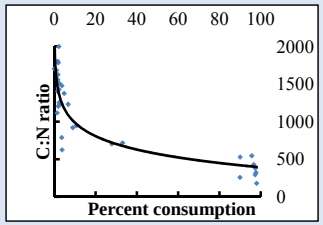
Classes one, two, and three did not significantly differ from each other at the $\alpha = .05$ significance level. These three classes exhibited mean consumption values of 10,6, and 14% respectively. Class 4 significantly differed from all other classes at the $\alpha = .05$ significance level, and exhibited very high consumption values averaging 95%. Properties associated with increasing decay were correlated with increased consumption.



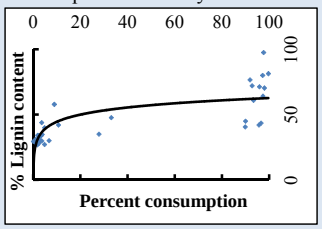
Consumption by decay class



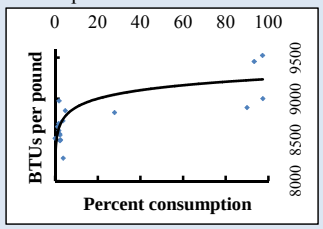
Consumption and decay



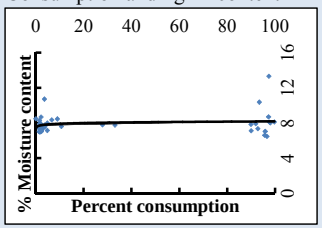
Consumption and C:N ratio



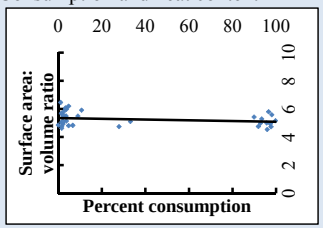
Consumption and lignin content



Consumption and heat content



Consumption and moisture content



Consumption and surface area:volume ratio

Conclusion

Consumption of CWD ranged from 6% to 14% in lesser degrees of decay (classes 1-3) and averaged 95% in more advanced stages of decay (class 4). Thus, stands with an abundance of highly decayed CWD may experience a greater loss of this material, and subsequently create more emissions and soil heating, than stands where CWD is in lesser states of decay. This difference in class and consumption favoring advanced decay may indicate that management tools such as Consume and FOFEM, which lump fuels broadly into sound or rotten categories, may furnish users with an adequate level of stratification to address the consumption of these fuels. Future research with remaining samples is scheduled for Spring of 2010 and may include exposing CWD to different levels of radiant heat to examine if similar trends are observed. During the Fall of 2009 CWD consumption was monitored on a prescribed fire. Data from this field operation may be compared to these laboratory findings to determine if trends found here are mirrored in a field burn setting.

References

Bertschi I, Yokelson RJ, Ward DE, Babbitt RE, Susott RA, Goode JG, Hao WM (2003) Trace gas and particle emissions from fires in large diameter and belowground biomass fuels. *Journal of Geophysical Research* **108**, 8.1-8.12.

Davis MR, Allen RB, Clinton PW (2003) Carbon storage along a stand development sequence in a New Zealand *Nothofagus* forest. *Forest Ecology and Management* **177**, 313-321.

Graham RT, Harvey AE, Jurgensen MF, Jain TB, Tonn JR, Page-Dumroese DS (1994) 'Managing Coarse Woody Debris in Forests of the Rocky Mountains. Research Paper INT-RP-477.' US Department of Agriculture, Forest Service, Intermountain Research Station.

Hyde JC, Smith AMS, Ottmar RD, Alvarado EC, Morgan P (2009) The Combustion of Sound and Rotten Coarse Woody Debris: A Review. *International Journal of Wildland Fire* **(In Review)**.

Maser C, Anderson RG, Cromack K, Jr., Williams JT, Cummins KW (1979) Dead and Down Woody Material. In 'Wildlife Habitats in Managed Forests, the Blue Mountains of Oregon and Washington. USFS Agricultural Handbook 553'. (Ed. J Thomas). (U.S. Department of Agriculture, Forest Service: Washington DC).

Acknowledgements: This research has been made possible by funding from the NWCG Smoke Committee (SmoC) via the US National Park Service and partial support from the National Science Foundation Idaho EPSCor Program and JFSP via 07-2-1-60. Combustion and properties analysis were made possible by use of the University of Idaho Forest Products Laboratory, Stable Isotopes Laboratory, and Center for Forest Nursery and Seedling Research. Thanks also to Chad Hoffman (UI) nd Dr. Ernesto Alvarado, University of Washington.

Joshua Hyde
Smoke Management and Air Quality Training Coordinator, University of Idaho