Impact of Fire On Wood Decomposition in Forest Soils of Western North America

Introduction

Organic matter (OM) decomposition is an important factor in assessing the impact of land management on soil carbon (C) cycling and C sequestration (pools). Due to past fire exclusion practices and recent drought conditions in western North America, the number of large, high intensity fires has increased in the last decade. Consequently, there has been much interest on the effects such fires have on soil organic matter pools and the decomposition of new and residual OM after the fires. While most decomposition studies after fire have concentrated on surface leaf litter, much less is known on mineral soil. As part of a comprehensive study on the impact of wild and prescribed fire on soil physical, chemical and biological properties in western North American forests, we used "standard" wood stakes as an "index" of fire effect on organic matter decomposition across a range forest types and mineral soil conditions. We give results from studies currently underway in different U.S. forest ecosystems on the impact of wildfire on wood decomposition rates in mineral soil.

This study uses standard wood stakes to study the effects of fire on surface and belowground OM decomposition rates. The advantages of using standard wood stakes is that wood is a component of both the litter layer and the mineral soil. It is also long-lived because it decomposes slowly and can thereby integrate soil temperature and moisture over long periods of time. In addition, a wood stake allows us to measure decomposition rates at various depths in the soil profile.

Authors

Deborah Page-Dumroese[1], Martin Jurgensen[2], James Pickens[2], Joanne Tirocke[1]

1-USDA Forest Service, Rocky Mountain Research Station, Moscow, ID USA

2- Michigan Technological University, Houghton, MI USA

Methods

This study is part of an international cooperative project evaluating the impact of fire practices, ecosystem type, and climate change on soil OM decomposition.

Stake Design

- Trembling aspen (*Populus tremuloides*) and loblolly pine (*Pinus taeda*) are the standard substrate used for wood stakes to contrast differing lignin and cellulose contents (softwood vs. hardwood) in the sapwood.
- Samples taken correspond to various depths (Fig. 1).
- Two measures of decomposition are used after stakes are extracted: compression parallel to grain test (ASTM 143 Sec 55-62) (Fig. 2) and weight loss.

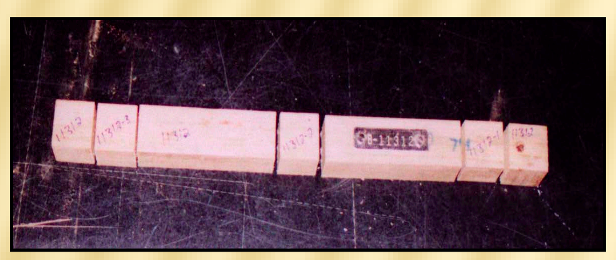

Fig. 1. Blocks at representative soil depths

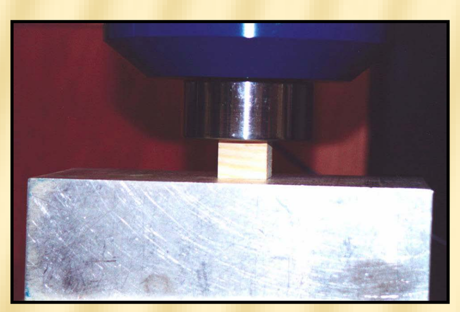

Fig. 2. Compression parallel to grain test

Study Design

- Twenty-five stakes of each tree species were installed in each subplot
- Soil temperature and moisture is recorded.
- Stakes are inserted on the top of the OM, at the mineral soil/OM interface, and into the mineral soil (Fig 3).
- Soil is removed from the hole with a square tool to minimize soil disturbance (Fig. 4)

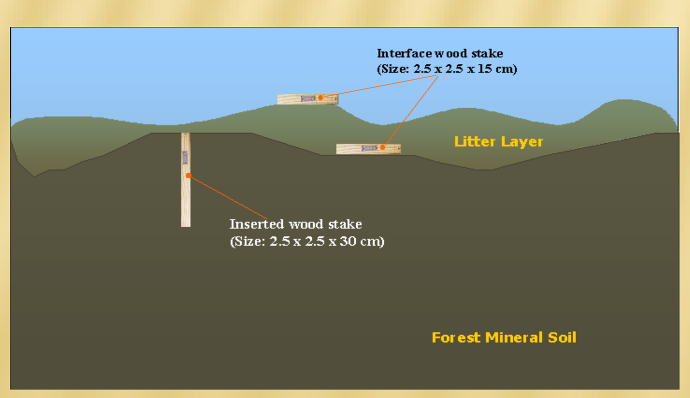

Fig. 3. Layout of stakes on and in the soil.

Fig. 4. Soil being removed from the ground with a square tool.

Sites and Mineral Soil Decomposition

The two sites (Fig. 5-8) encompass a range of site conditions (texture, moisture, and temperature). Both sites burned during the 2000 wildfires and each had a control (unburned) stand adjacent to the burned area. Inserted stakes sampled annually for 5 years on the Bitterroot National Forest showed different decomposition rates depending on treatment, soil depth and stake species (Fig. 9-10).

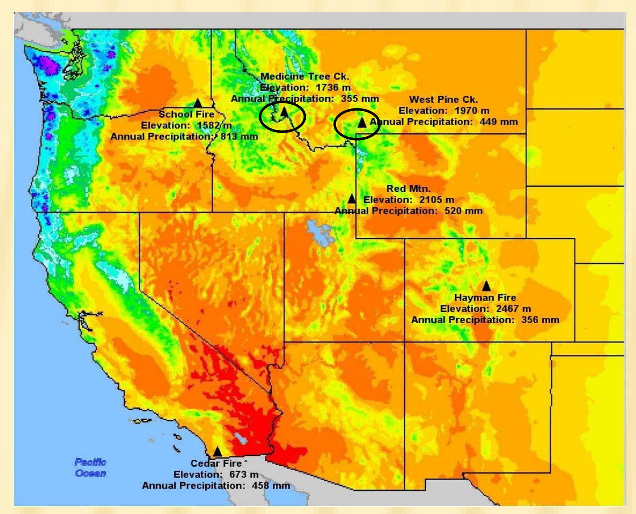

Fig 5. Plots from Medicine Tree And West Pine Creek were used.

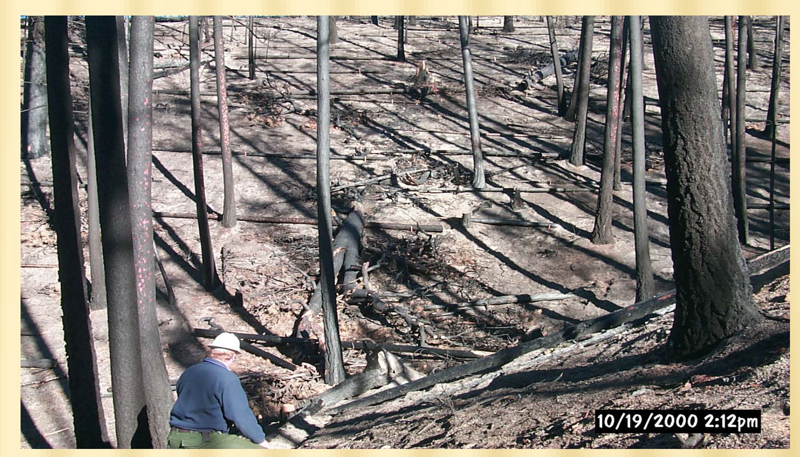

Fig. 6. Bitterroot National Forest. Medicine Tree Study site.

Fig 7. Landscape view of the Bitterroot National Forest

Fig 8. Gallatin National Forest. West Pine Creek Study site.

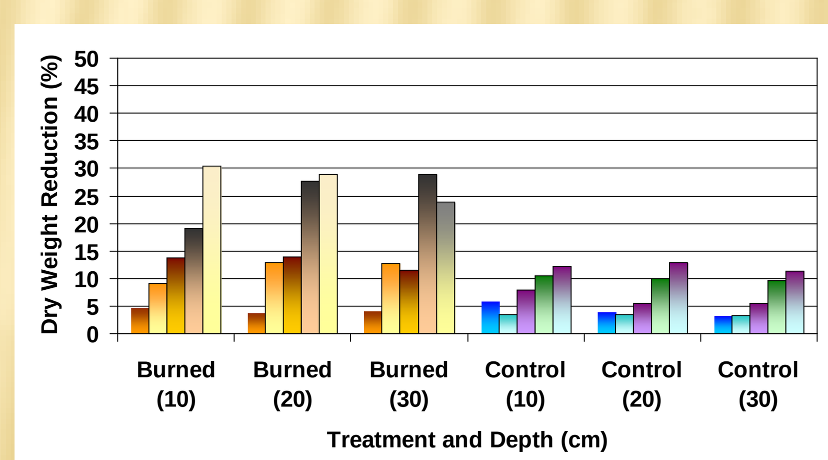

Fig 9. Bitterroot National Forest – pine stake dry weight reduction over 5 years (each bar represents 1 year).

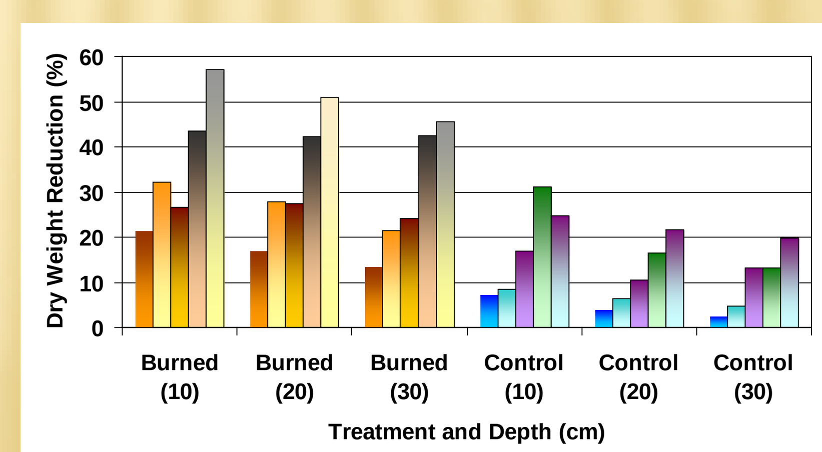

Fig. 10. Bitterroot National Forest – aspen stake dry weight reduction over 5 years (each bar represents 1 year)

Surface Decomposition

Within each study site, decomposition at the soil surface was governed by temperature and moisture differences.

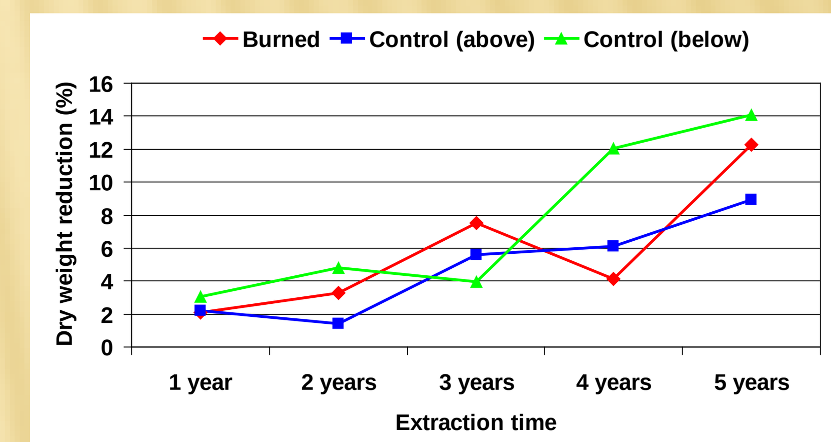

Fig. 11. Bitterroot National Forest – pine stakes at the interface between the forest floor and mineral soil had the greatest amount of decomposition after 5 years.

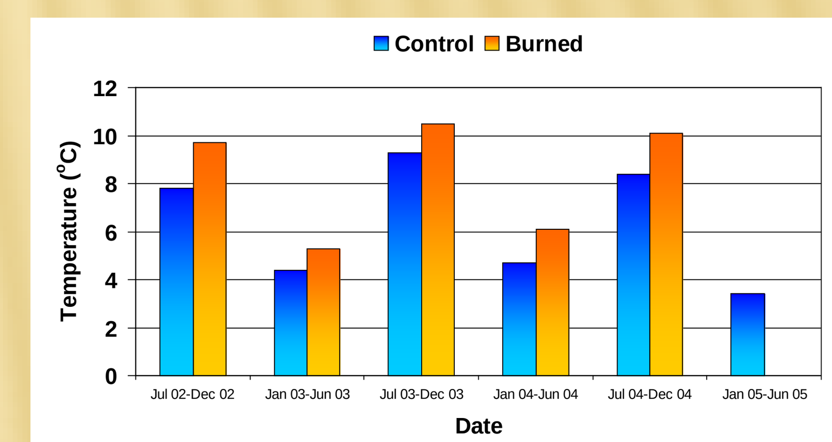

Fig.12. Bitterroot National Forest – Temperature differences between the control (unburned) and burned study sites. The control sites were cooler than the burned sites.

Summary

Wood decomposition on the Bitterroot and Gallatin National Forests (data not shown from the Gallatin) was a sensitive indicator of temperature or moisture (data not shown) differences. As expected, aspen stakes decayed much faster than pine stakes at both sites. Because of the overall increase in soil temperature after wildfire, decomposition in the mineral soil was much greater than in the unburned stands. Surface stakes often respond differently than stakes in the mineral soil. **In other studies** in the western US, broadcast burning appears to have little effect on decomposition. However, slash pile burning (intensive heat and duration) eliminates decomposition organisms from the burn pile soil for at least 3 years.

Factors that alter soil temperature and moisture will also impact biological activity. These abiotic and biotic changes will also alter C sequestration.