# Effects of Wildfires on Soil Enzyme Activities

**Katherine Amberg-Johnson[1]**
**[1]Lawrence Berkeley National Laboratory- Department of Ecology**

## Abstract

Soil microbes have an important role in the global carbon cycle. They contribute to the degradation of plant material and emit $CO_2$ fixed by plants back to the atmosphere. The activity of extracellular enzymes, that allow them to decompose organic plant material, may vary depending on the conditions of the soil. Wildfires, for example, change the soil structure and chemistry. Moreover, in places such as the northern boreal forests they are expected to increase in frequency and severity due to global climate change.

**This study aims to detect the activity of several enzymes involved in degradation of plant material; namely cellulases, oxidases and chitinases, in soils affected by wildfires in Alaskan boreal forests.** Top soils from five wildfire and control locations were collected. Overall, the control soils had the highest amount of activity of the cellulases, compared to corresponding post-fire sites in most of the sites tested. Oxidases; involved in lignin degradation, also followed this trend. The chitinase activity differed depending on the location. These results indicate that an aspect of wildfire is suppressing the activity of cellulases and oxidases in the soil, and the magnitude of the effect is highly variable, depending on the soil's location and season of origin.

## Methods

### Sample Locations

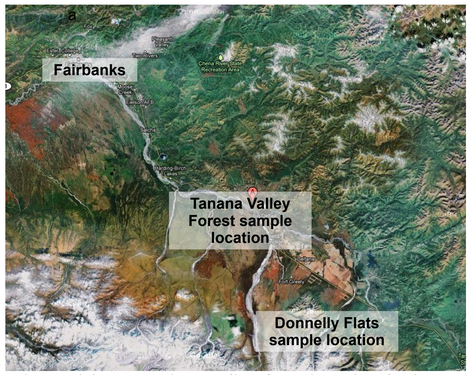


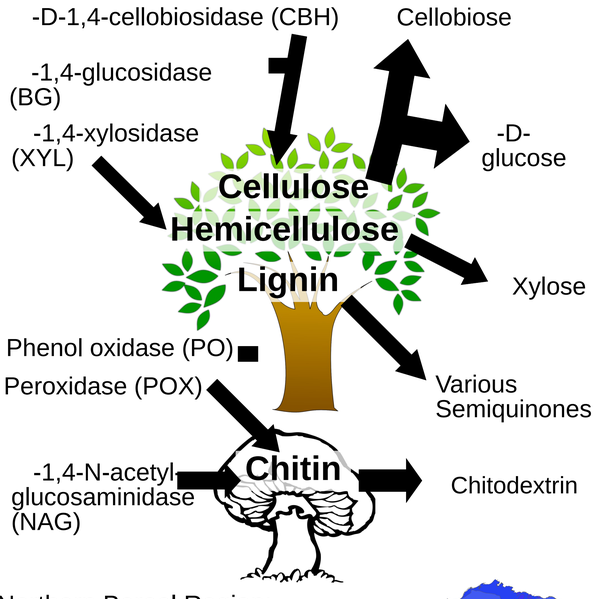

Figure (a): Map of sampling locations in Alaska

### Experimental Design

- All samples were taken in July or September of 2010.
  - In Tanana Valley Forest (TVF), samples were chosen from sites that were exposed to wildfire in 2004, 2010, and control.
  - In Donnelly Flats (DF), samples were from sites that were exposed to wildfire in 1956, 1987, 1999 and control.
- To test the activity of enzymes, soil samples were homogenized in sodium acetate buffer (pH=5.0)
  - To test the activity of PO and POX, homogenate was mixed with L-3,4-dihydroxyphenylalanine. Color change from this reaction was measured with a spectrophotometer.
  - For BG, CBH, NAG, and XYL activity homogenate was mixed with their corresponding MUB (4-methylumbelliferone) bound substrate. As MUB was cleaved from the substrate, light emitted was measured at 460 nm.

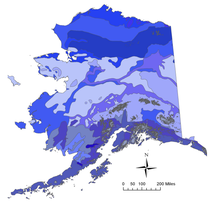
## Introduction

### Enzymatic Reactions




Northern Boreal Region:

- represents 30% of the world's forested area
- makes up an estimated 12-42% of the global soil carbon pool




- An average wildfire leads to approximately 1,000-2,000 g C/m$^2$ released as carbon dioxide
- As global climate change progresses, fires are projected to increase in frequency and severity in the northern boreal region

## Results

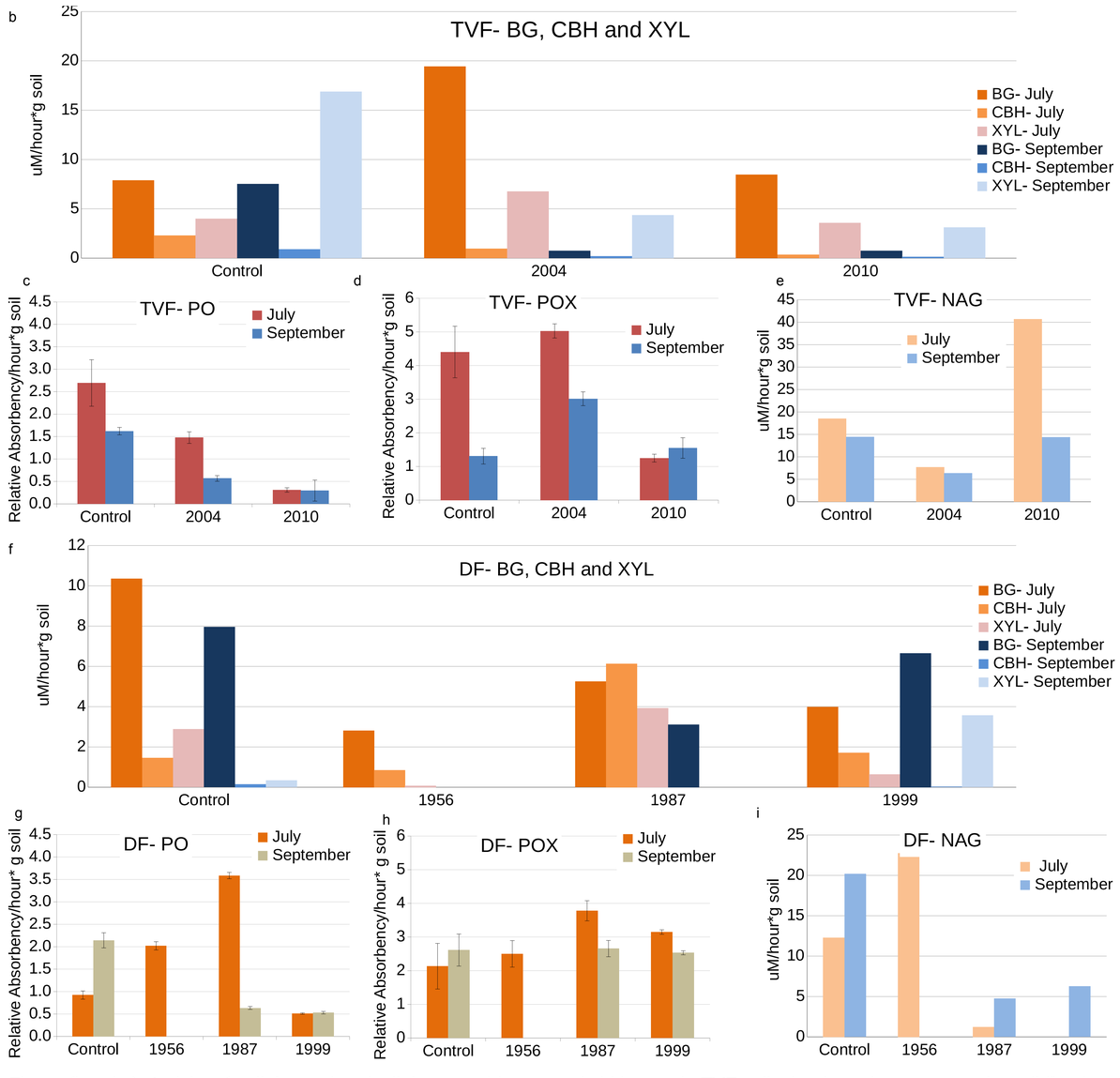



Figure (b,c,d,e): Activity of cellulases, hemicellulases, oxidases, and chitinases in TVF soils that have been exposed to wildfire in 2004, 2010 and control.
Figure (f, g, h, i): Activity of cellulases, hemicellulases, oxidases and chitinases in DF soils that have been exposed to wildfire in 1956, 1987, 1999 and control.

## Conclusion

- Sites exposed to wildfire have an overall lower enzymatic activity than sites not exposed to wildfire.
  - Wildfires were suppressing the activity of cellulose (BG and CBH) and hemicellulose (XYL) and soils from more recent wildfire events have more of a reduction in enzymatic activity.
  - In lignin degradation, the PO activity was decreased where as an over expression of POX was observed as the soil recovers from a wildfire.
  - Chitinase activity was found to be location depended where wildfire could be stimulating the activity.
- Activity of enzymes collected in July soil was higher than that of corresponding soil collected in September, indicating that temperature is stimulating activity.
- Differences in activity and activity trends among different locations indicate that wildfire events effect every location differently as the activity of the enzymes detected are linked to type and metabolic capabilities of the microorganisms that can survive the event.

Future research focus

- Microbial community changes between wildfire and control samples needs to be studied to link observed changes in the activity to their possible origins

## Acknowledgements

This work was supported by the Center for Science and Engineering Education at Lawrence Berkeley National Laboratory, U.S. Department of Energy, Office of Science, Department of Ecology. I would like to thank my mentor Janet Jansson for the opportunity to work on this project and Neslihan Tas for all her guidance. I would also like to thank Sandra Dooley, UC Irvine for providing the soil samples.