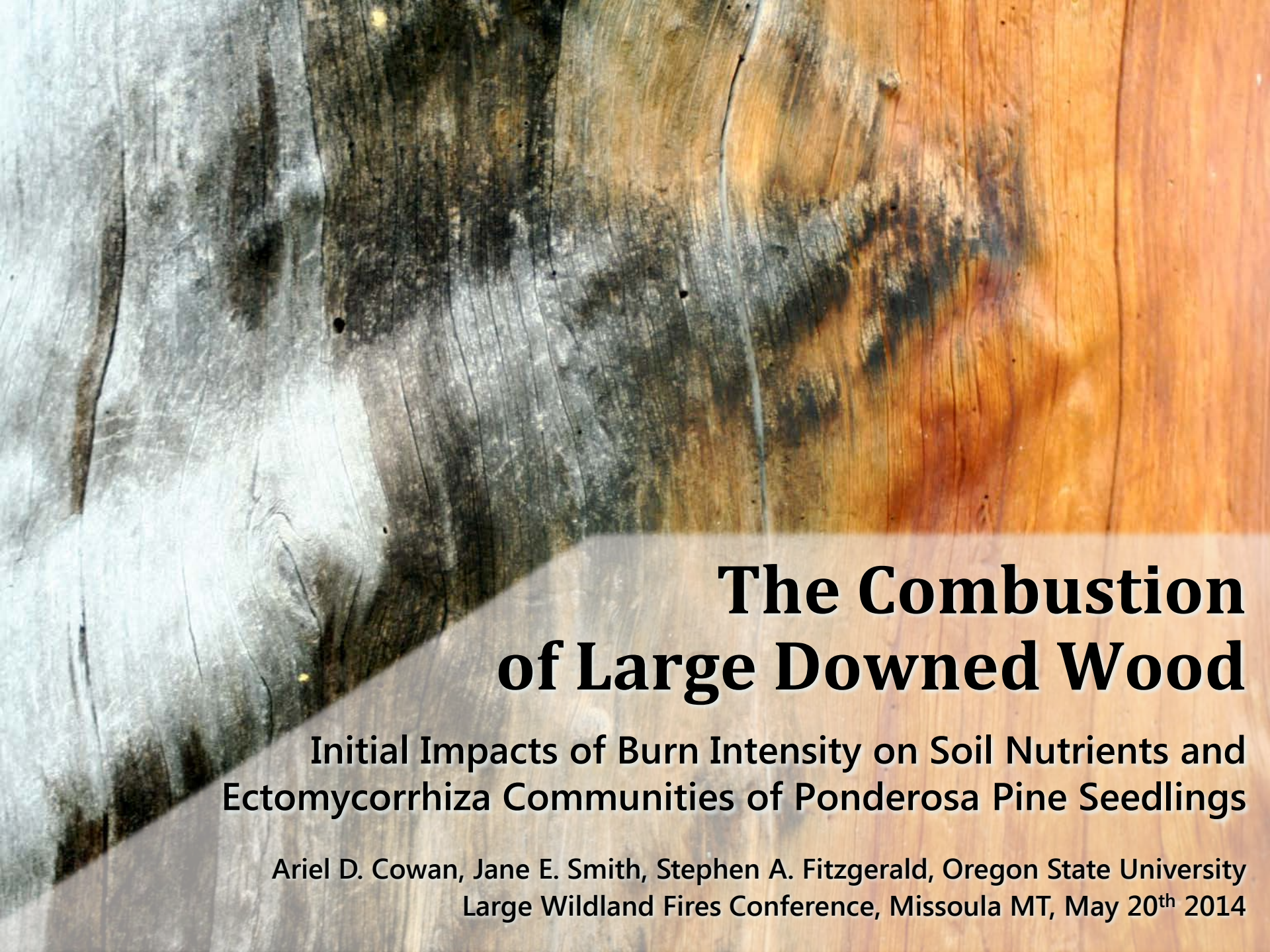


The Combustion of Large Downed Wood

Initial Impacts of Burn Intensity on Soil Nutrients and Ectomycorrhiza Communities of Ponderosa Pine Seedlings

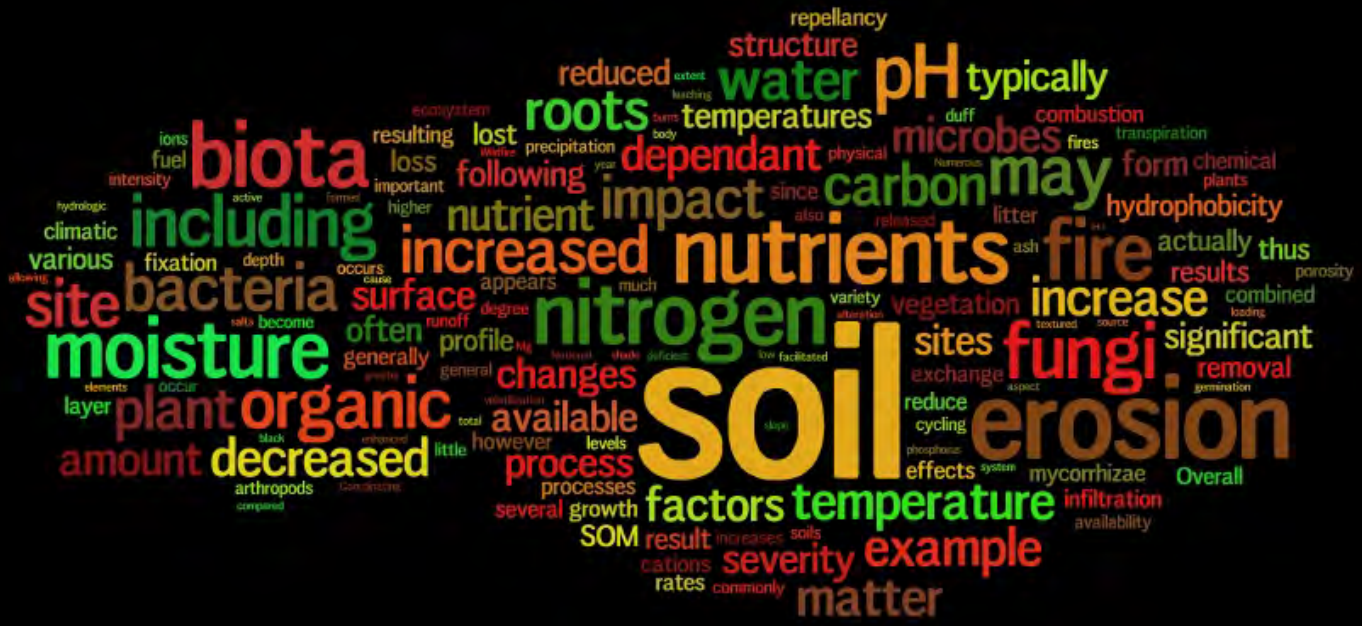
Ariel D. Cowan, Jane E. Smith, Stephen A. Fitzgerald, Oregon State University

Large Wildland Fires Conference, Missoula MT, May 20th 2014

Presentation Goals

Impacts of Fire

http://i-farmtools.iastate.edu/i-farm/soil_profile2



Intensity

- Temperature
- Duration

Severity

- Impact
- Product of intensity

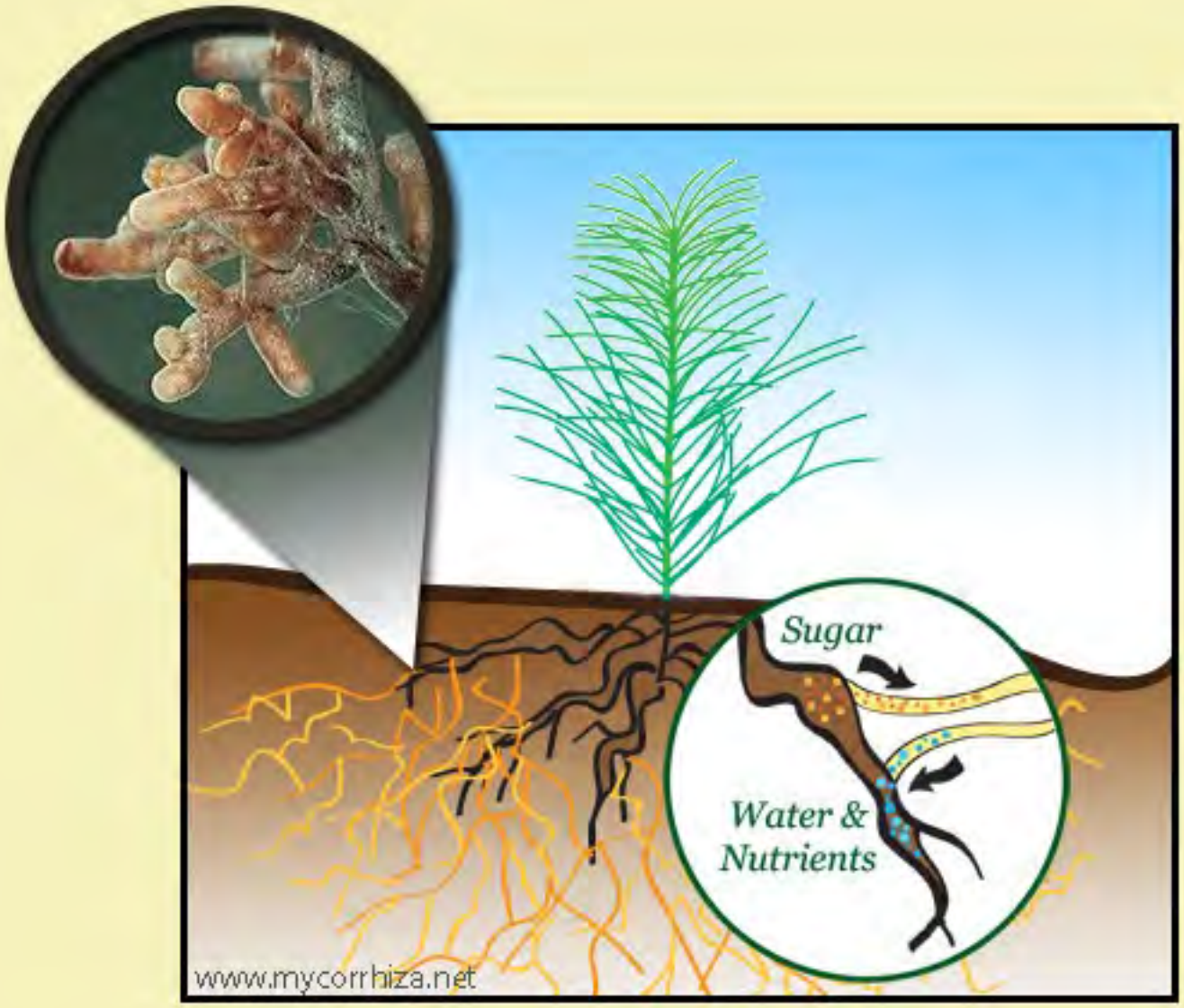
Combustion of downed wood = High Intensity Burn

High intensity can create high severity impact on microbes and nutrients

Fire Temperature Threshold

Biological component threshold	Temperature (°C)	Reference
Plant roots	48	Hare, 1961
Small mammals	49	Lyon et al., 1978
Protein coagulation	60	Precht et al., 1973
Fungi – wet soil	60	Dunn et al., 1985
Seeds – wet soil	70	Martin et al., 1975
Fungi – dry soil	80	Dunn et al., 1985
Nitrosomonas spp. – wet soil	80	Dunn and DeBano, 1977
Nitrosomonas spp. – dry soil	90	Dunn and DeBano, 1977
Seeds – dry soil	90	Martin et al., 1975

Source: Neary et al. 1999



Ectomycorrhizal Fungi (EMF)

create symbiotic relationships with plants

EMF increase growth and survival of conifer seedlings

http://www.mycorrhiza.net

Ponderosa Pine – Important in Central Oregon

Evolved with fire

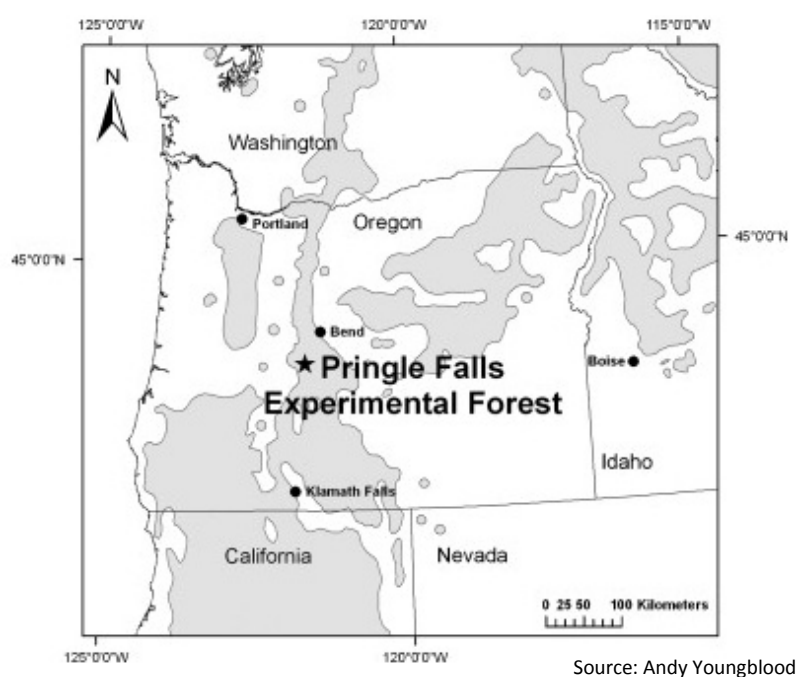
Dependent on EMF

Does burn intensity alter EMF recruitment on ponderosa pine seedlings?

1. Do soil nutrient contents differ among burn intensities?
2. Does early successional EMF species composition differ among burn intensities?
3. Do correlations exist among burn-related changes to soil nutrients and EMF species composition on ponderosa pine seedlings?

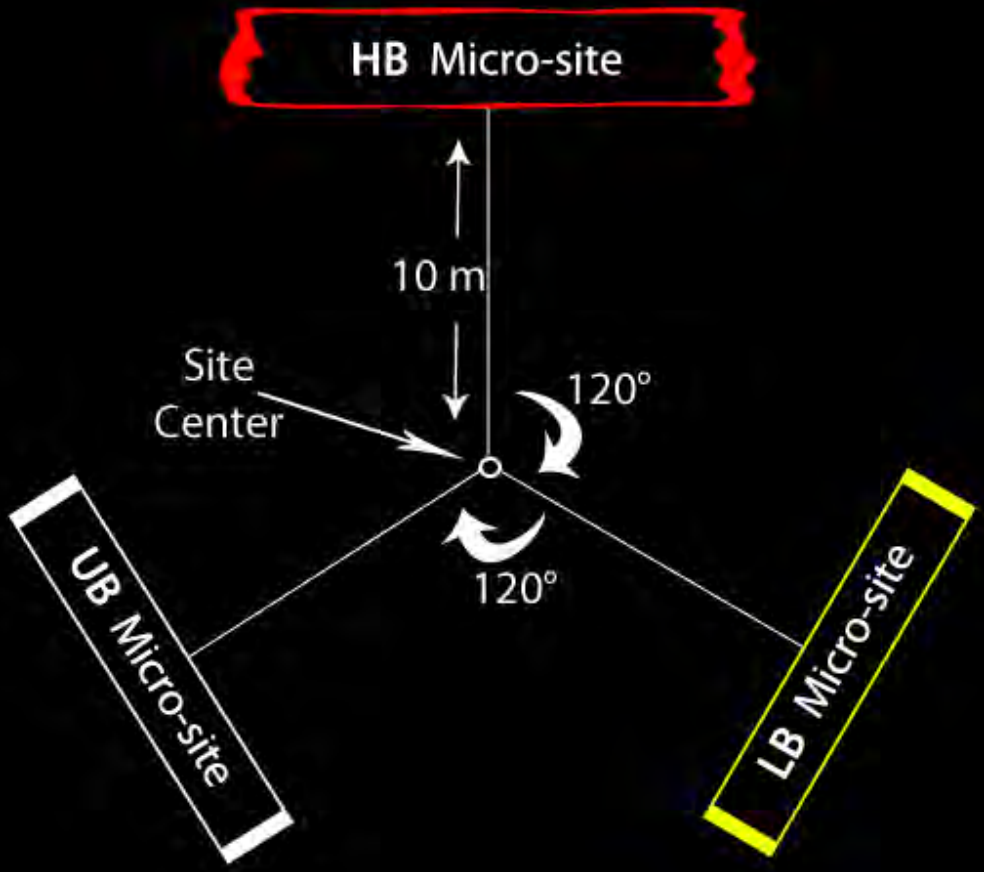
➡ How might these changes impact ponderosa pine seedling establishment?

Lookout Mountain



Source: Andy Youngblood

- USFS Pringle Falls Experimental Forest
- La Pine, OR
- Deschutes National Forest
- *Pinus ponderosa*: Mixed age/Secondary
- Thinned and Masticated



HB = high intensity burn treatment

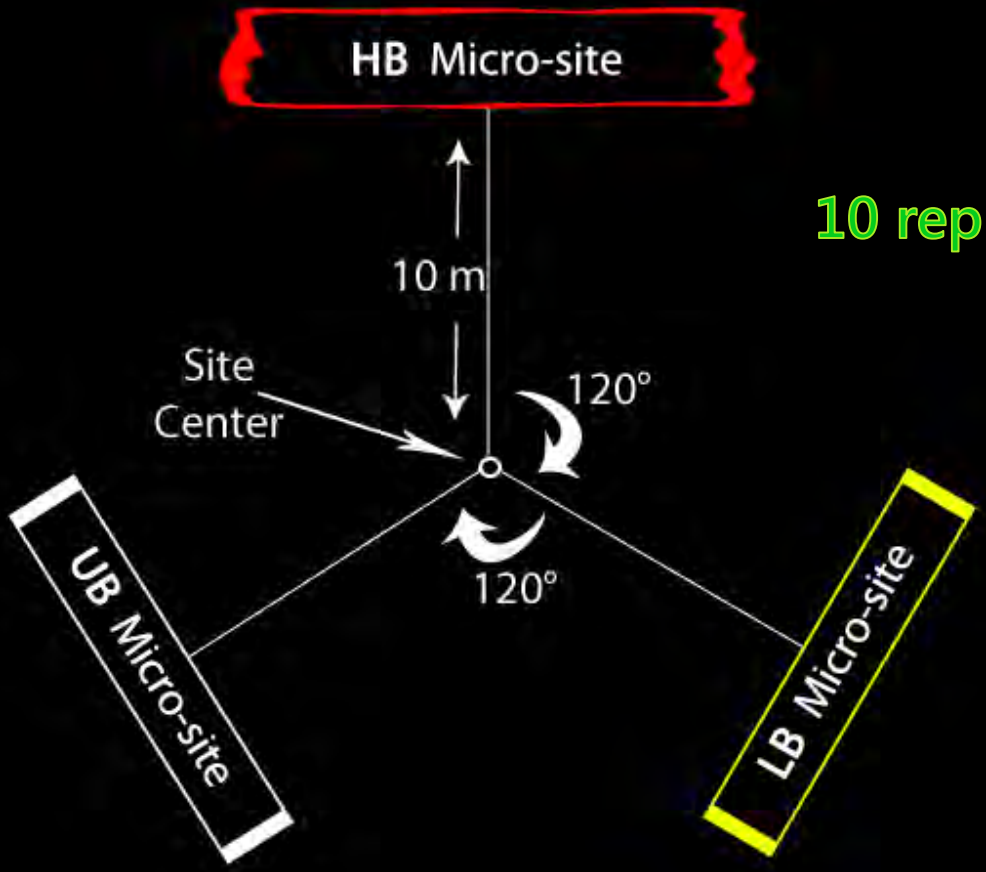
LB = low intensity burn treatment

UB = unburned control

HB treatment: M E G A - L O G

Photo Credit: Doni McKay


Photo Credit: Doni McKay

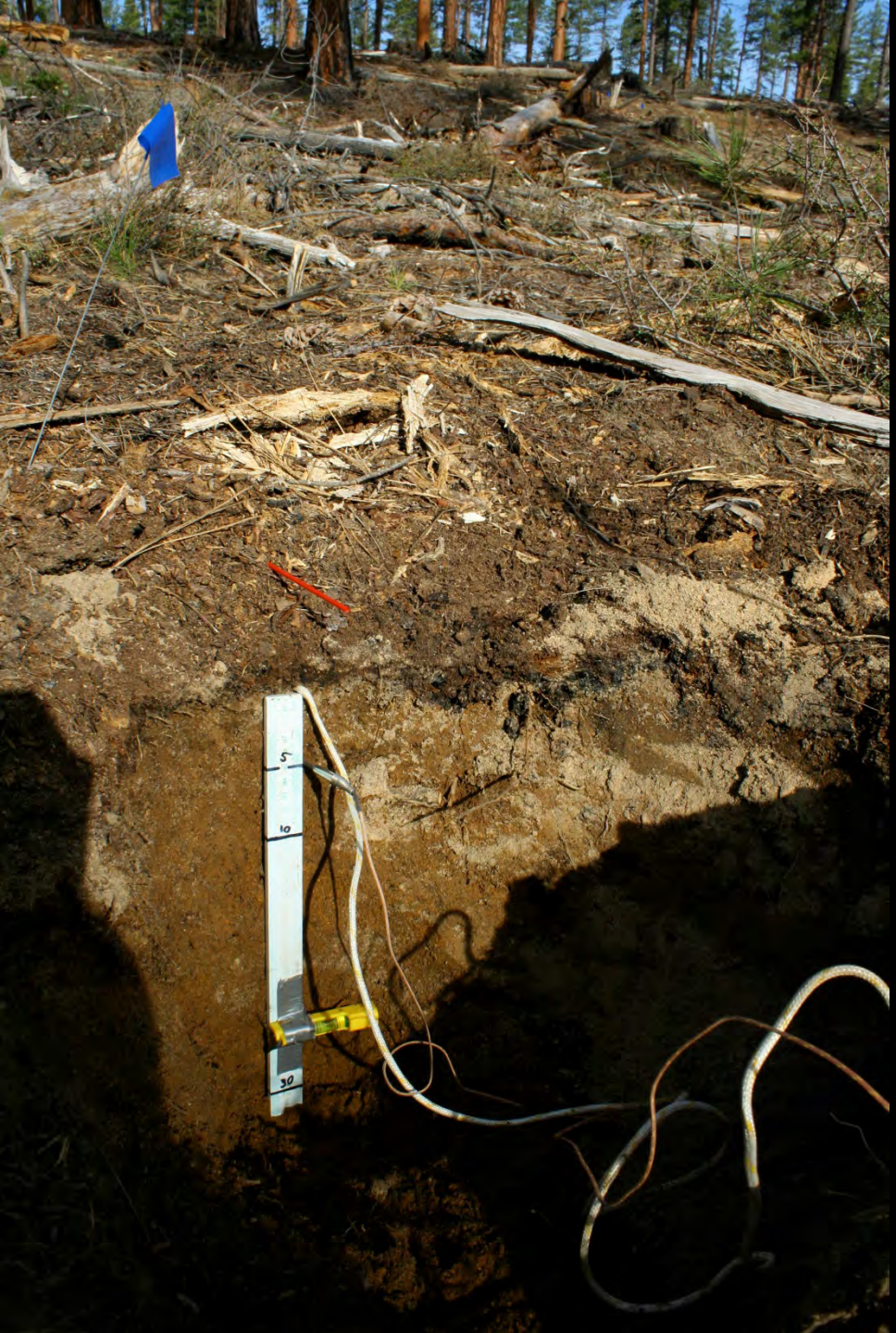


10 replicated sites

HB = high intensity burn treatment

LB = low intensity burn treatment

UB = unburned control



Temperature Recording

Glass-braided, Stainless Steel, and PVC thermocouple probes

HB

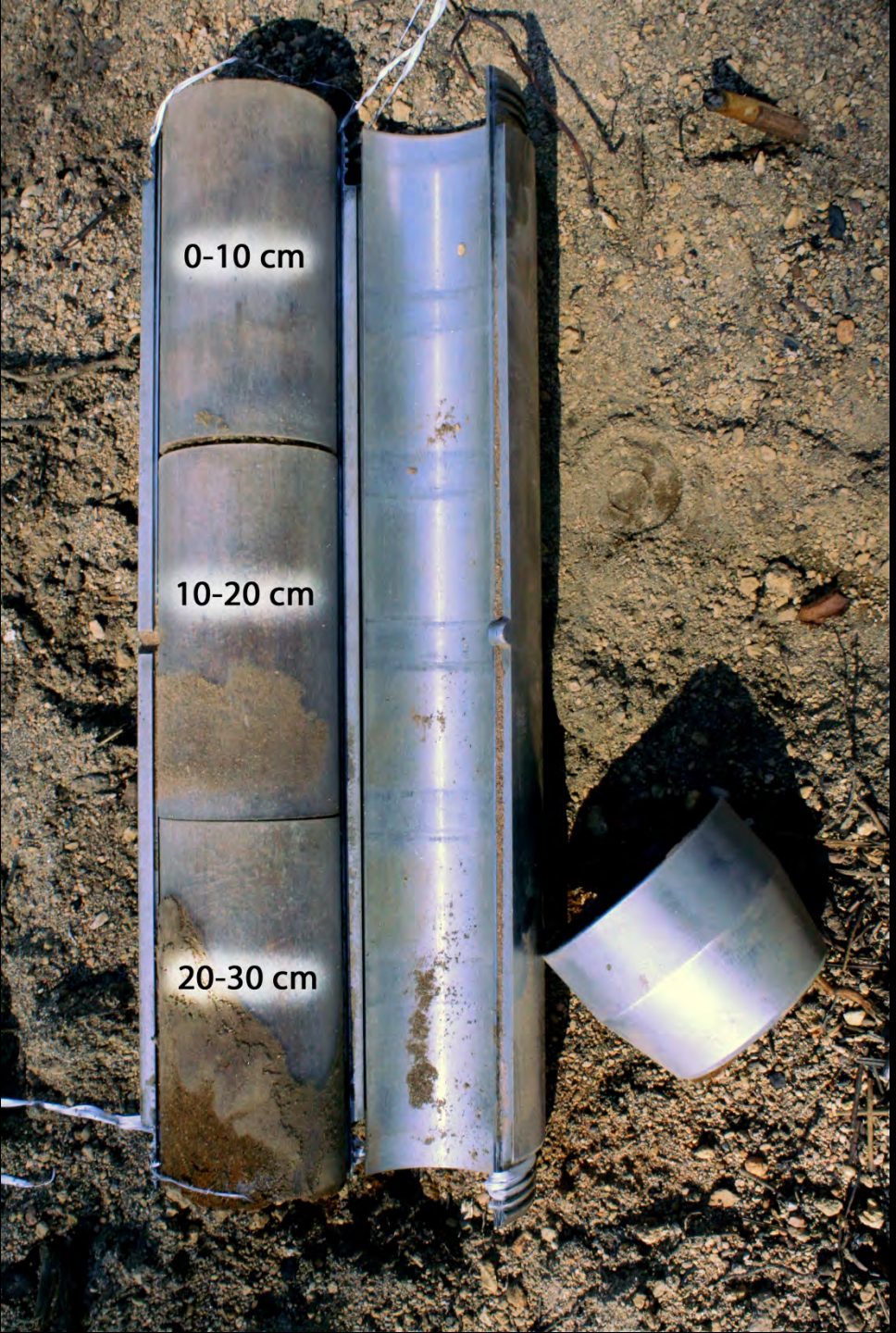
0, 5, 10, and 30 cm depths

LB

0 and 5 cm depths

HB micro-site BEFORE

AFTER

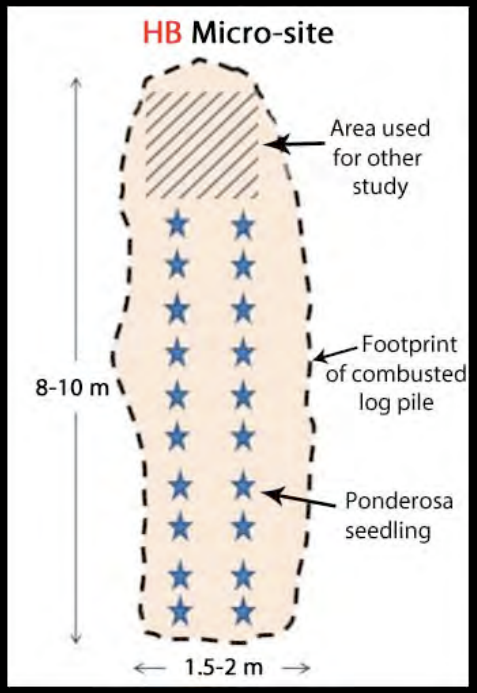


Soil Sampling

C, N, P, K,

SOM, Ca, Mg,

%MC, and pH


HB Micro-site
Area used for other study
Footprint of combusted log pile
Ponderosa seedling
8-10 m
1.5-2 m

Four Months Later

Harvested

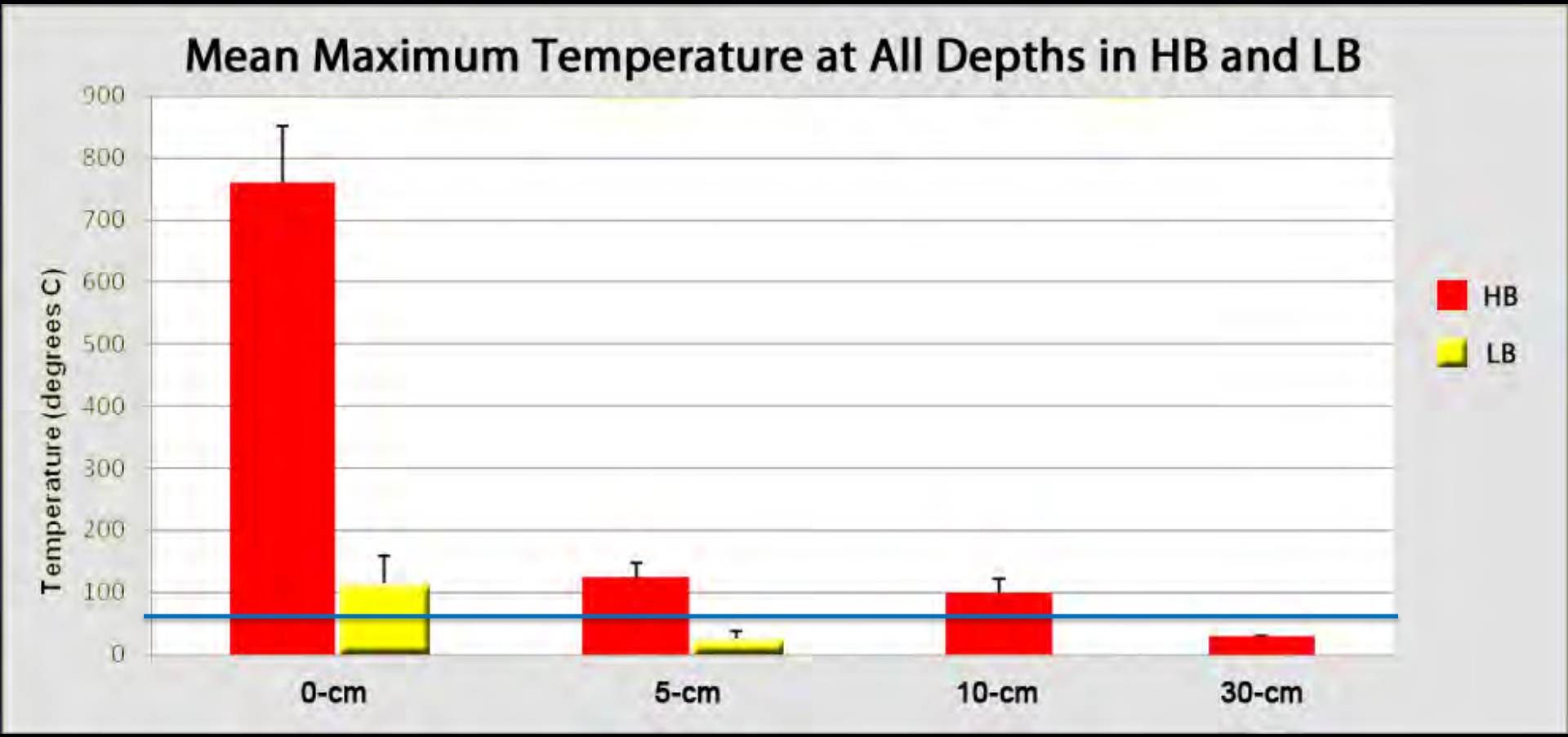
3 seedlings/micro-site

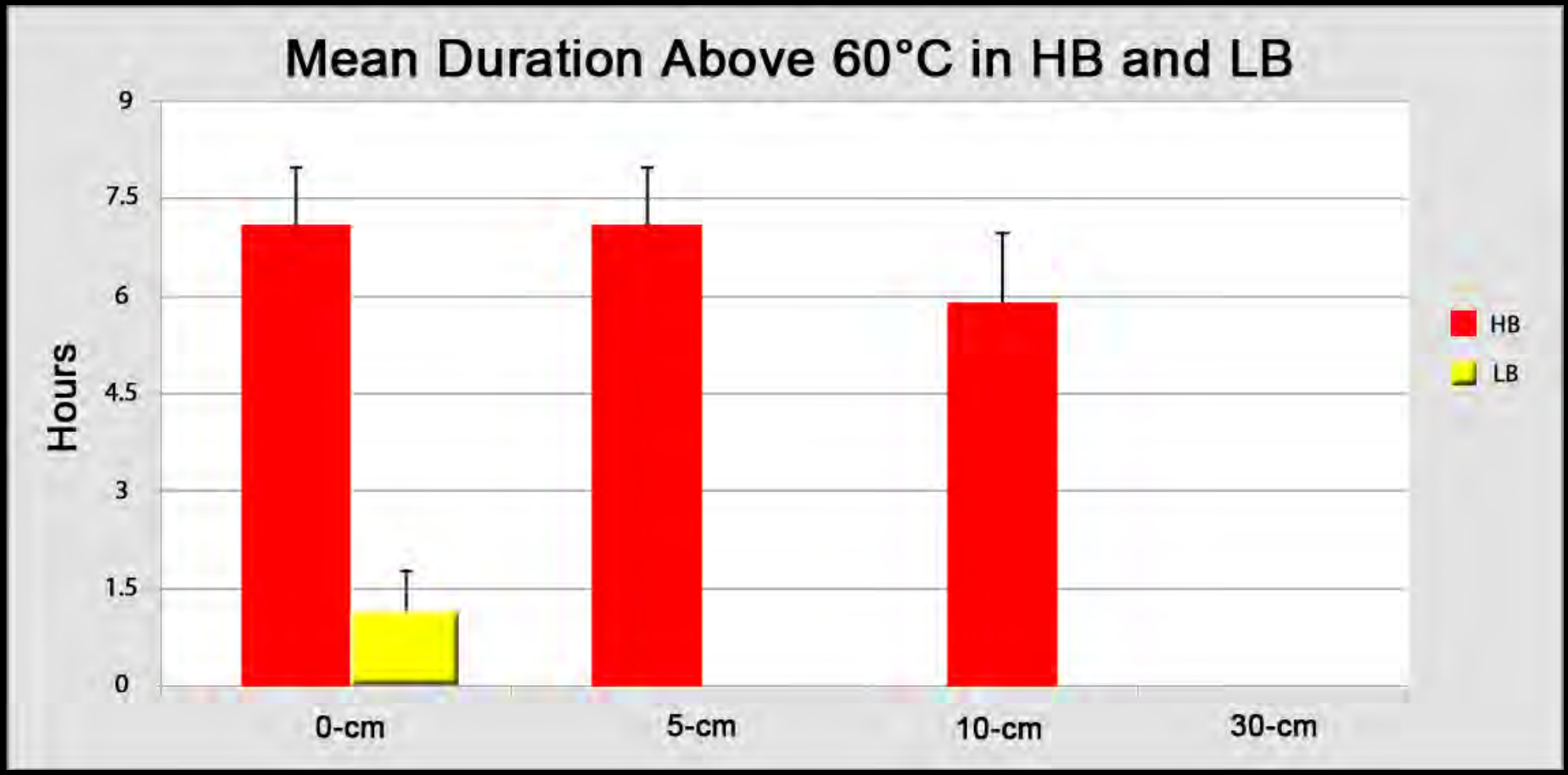
100 root tips selected from random squares in grid

- Root tips grouped by morphotype
- DNA extracted from 1-2 tips per group

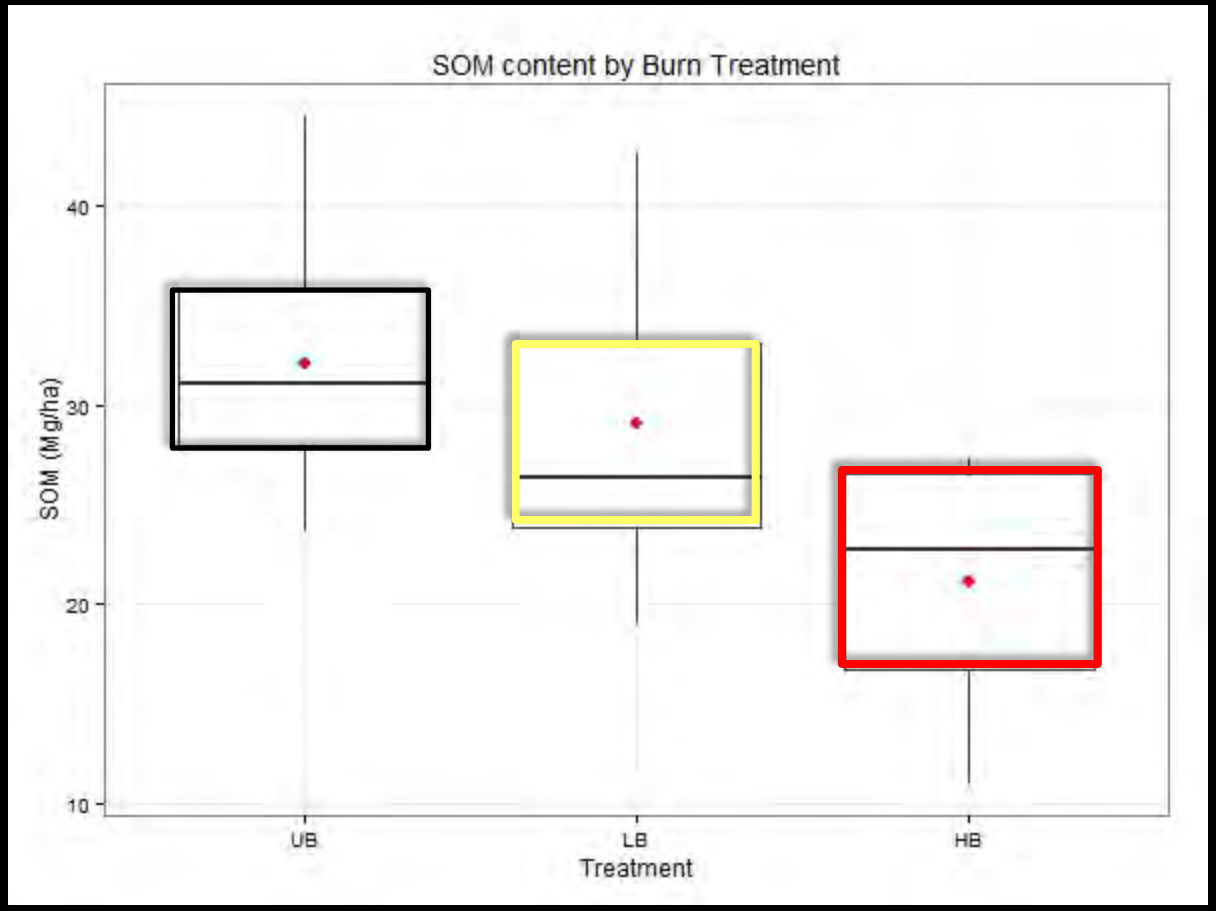
- Polymerase Chain Reaction (PCR)
- Sanger sequencing
- Taxonomic names assigned to sequences
    - NCBI Database
- Statistical analysis comparing HB, LB, and UB

Preliminary Results


Mean Maximum Temperature at All Depths in HB and LB
Temperature (degrees C)
900
800
700
600
500
400
300
200
100
0
0-cm
5-cm
10-cm
30-cm
HB
LB


Mean Duration Above 60°C in HB and LB
Hours
9
7.5
6
4.5
3
1.5
0
0-cm
5-cm
10-cm
30-cm
HB
LB

Soil Organic Matter (SOM)



Community Analysis

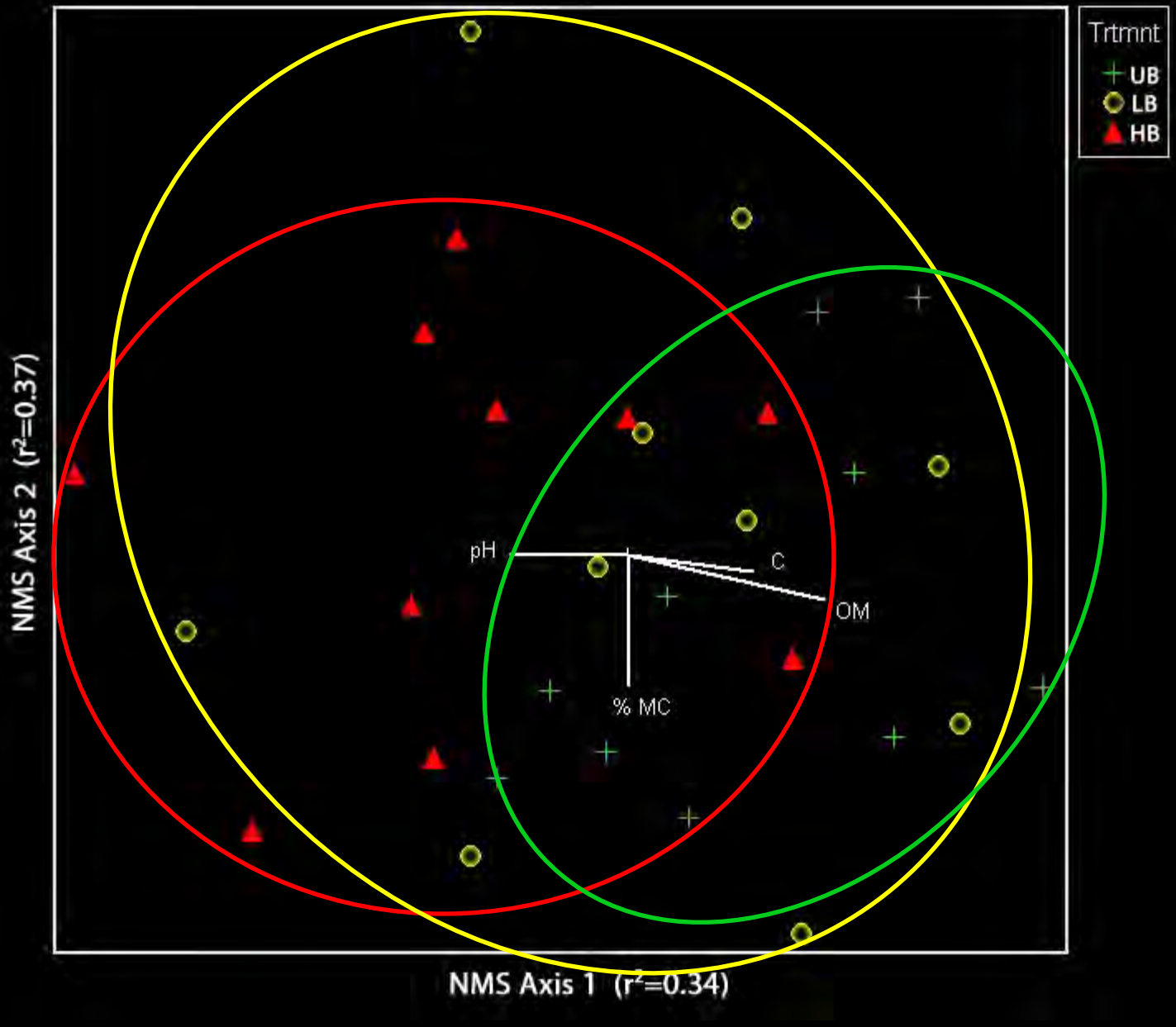
Species Composition:

Comparison	A-statistic	FDR-adjusted p-values
HB vs LB	0.01	0.30
HB vs UB	0.04	0.03
LB vs UB	-0.01	0.45

Species Richness and Diversity (averaged over micro-sites):

Treatment	N	Richness	Max	Min	SD	Simpson's Diversity
HB	10	6.9	10	5	1.84	0.65
LB	10	8.6	17	4	3.63	0.74
UB	10	7.2	11	5	2.01	0.68

Species N=64


Trtmnt
UB
LB
HB
pH
C
OM
% MC
NMS Axis 2 (r²=0.37)
NMS Axis 1 (r²=0.34)

1. **Do soil nutrient contents differ among burn intensities?**
   - Difference in SOM between UB and HB soils
   - Greatest overlap between UB and LB soils

2. **Does early successional EMF species composition differ among burn intensities?**
   - Difference between seedlings grown in UB and HB soils
   - No difference in species richness and diversity

3. **Do correlations exist among burn-related changes to soil nutrients and EMF communities on ponderosa pine seedlings?**
   - Species composition, pH, C, SOM, MC
   - HB associated with ↓ C, SOM, ↑ pH

EMF Resilience

- Inoculum from nearby refuge
- Advantage of mixed severity fire
- Competition between species
- Analysis continues…

Acknowledgements

Jane Smith
Stephen Fitzgerald
Carol Shestak
Matt Busse
Debbie Dumroese
Tara Jennings
Rich Cronn
Dan Luoma
Joyce Eberhart
Dan Mikowski
Bend and Redmond Fire Crews
Lisa Ganio
Ariel Muldoon
Liz McWilliams
Joseph Cagle
Greg Brenner
Doni McKay
Forest Mycology Lab
USFS PNW Research Station
Mike Vernon

Thank you!

OSU Oregon State University College of Forestry

FOREST SERVICE US DEPARTMENT OF AGRICULTURE

PNW

Questions?

References:

Agee, J. K. 1998. The landscape ecology of western forest fire regimes. Northwest Science, **72**(17), 24-34.

Huff, M. H., Ottmar, R. D., Alvarado, E., Vihnanek, R. E., Lehmkuhl, J. F., Hessburg, P. F., and Everett, R. L. (1995) Historical and Current Forest Landscapes in Eastern Oregon and Washington: Part II, Linking Vegetation Characteristics to Potential Fire Behavior and Related Smoke Protection. USDA Forest Service, General Technical Report PNW.

Johnson DW, Curtis PS (2001) Effects of forest management on soil C and N storage: meta analysis. For Ecol Manage 140:227–238

Neary, D.G., Klopatek, C.C., DeBano, L.F., Ffolliott, P.F., 1999. Fire effects on belowground sustainability: a review and synthesis. For. Ecol. Manage. 122, 51–71.

Neary, D.G., Ryan, K.C., and DeBano, L.F. 2005. Wildland Fire in Ecosystems: Effects of Fire on Soils and Water. USDA Forest Service, Rocky Mountain Research Station, Ogden, UT, 250 pp.

Tiessen H, Cueva E, Chacon P (1994) The role of soil organic matter in soil fertility. Nature 371:783–785