



Microbial Mediation of Ponderosa Pine Regeneration Under Fire and Drought

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Significance

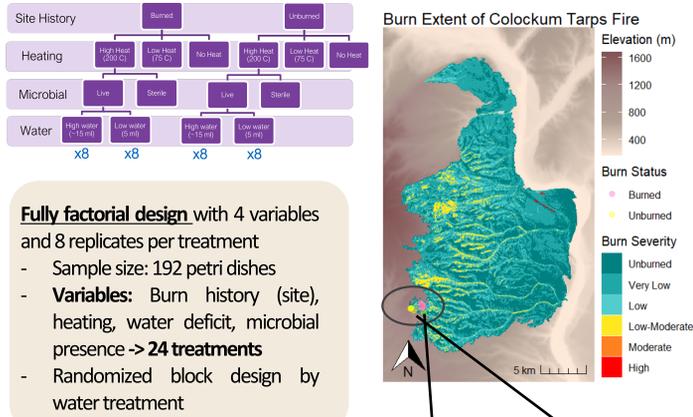
Ponderosa pine forests in eastern Washington are adapted to a drought-prone climate, yet wildfires of increasing severity and persistent water deficit threaten their regeneration in a rapidly changing climate. **Microbial communities and fire management strategies play a critical role in determining ponderosa pine resilience to climate change by facilitating drought and heat tolerance while supporting Indigenous knowledge systems.**



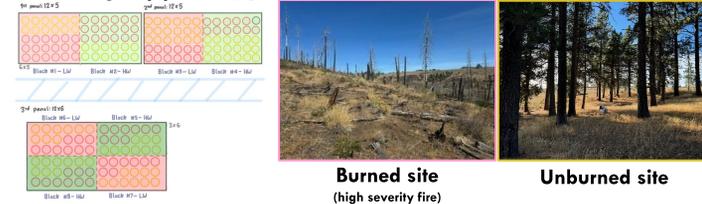
Lab website:



Study Design



Block design by panels



Methods

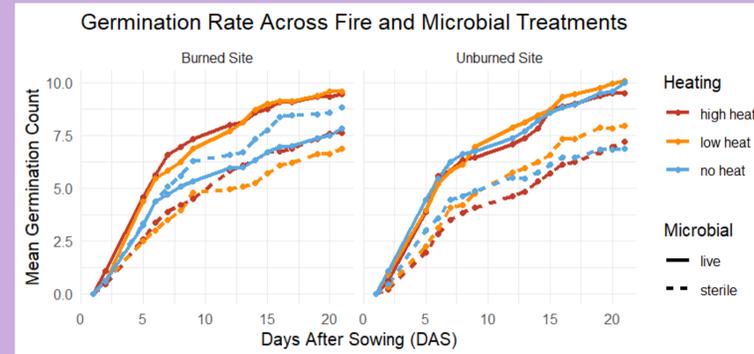
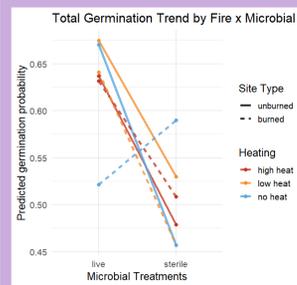
- 1 Soil Preparation:** Collected and pooled field soils, heating to 75° C and 200° C for 20 minutes and autoclaving at 121° C for 45 minutes.
- 2 Dish Preparation:** Sterilized and soaked ponderosa pine seeds for 48 hours. Plated soils and seeds to sterile petri dishes with 10 ml of initial watering.
- 3 Germination Experiment:** Watered by deficit treatments (5 ml, up to 15 ml) and grew for 21 days under a 16h photoperiod.
- 4 Data Collection/Analysis:** Recorded germination count across study period, along with root: shoot and biomass measurements. Monitored seedling growth (left graph). Data processing and visualization in RStudio.

Results

Germination

Summary:

- **Microbial presence** increases overall and total germination
- Fire treatments (heated soils) improve germination generally, particularly **low heat fires**



- **Burned site:** **Low** and **high heat** treatments significantly increase germination -> microbial presence + pathogen removal via heating
- **Unburned site:** **Live** soils significantly improve germination, **low heat-sterile** is significantly higher than other sterile treatments
- **Site x heat:** Lower germination rates in high severity (burned sites) but recovery of germination rates after **low heating**
- **Pathogen impact:** Significant difference in **no heat treatments** with higher germination in sterile-**no heat** (burned) being indicative of pathogen inhibitive effects for live-**no heat** (burned) soils.

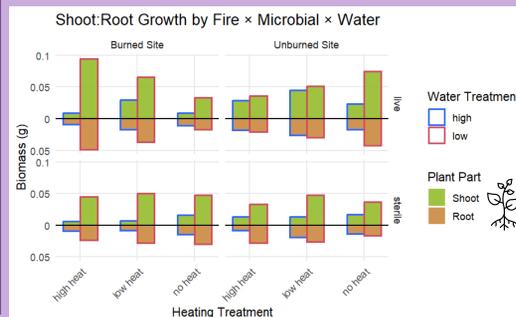


Establishment

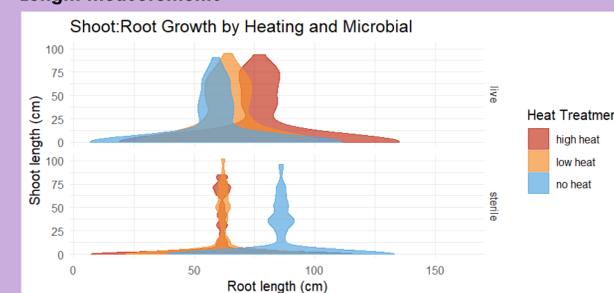
Summary:

- **Reheating** previously burned soils increases seedling growth, especially under **high heat**
- **Unburned soils:** Heating reduces seedling growth due to lack of nutrients

Biomass measurements



Length measurements



- **High heat** promotes highest seedling growth in previously **burned soils** (burned site)
- **Low heat** in burned and unburned soils produce **high** seedling growth
- **Baseline:** no heat, unburned (live soil) has high growth (normal growing conditions)

- Live soils under **high heat** have similar high growth to sterile, **no heat** soils (baseline)
- Adding heat to **sterile soils** reduces growth while **live soils** promote growth due to increased nutrient access

Key Findings

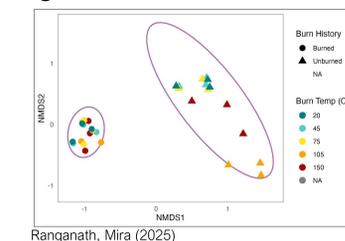
Our results suggest that ponderosa pine germination and growth is significantly improved by **low intensity fires and live soils** across sites of differing microbial communities and water conditions.



- **Fire treatments:** **Low heating** of soils improves both germination success and seedling growth, indicating pathogen removal while retaining nutrients.
- Seedlings in **burned soils** favor reheating, especially under **low heat**, indicating fire-resilient soil community and boosting germination and growth.
- **Unburned soils** benefit from microbes with high germination success and seedling vigor.
- **Pathogen removal:** Reheating previously burned soils selects against seedling pathogens and improves germination.

Future Directions & Applications

- **Forest management:** In sites experiencing regeneration failure following severe, stand-replacing fires, pathogens may be inhibiting seedling germination and establishment. Our data indicates that treating these soils with **low-intensity fire** may be sufficient to remove these pathogens and recover germination rates.
- **Climate adaptation:** Fire burned sites are more resilient to future high intensity fires induced by climate change. To reduce the risk of severe stand-replacing fires and seedling regeneration failure, low-intensity fires are recommended for fire-suppressed (unburned) sites given moderate seedling growth and high germination.



Future work:

Linking germination and growth data to fire-resilient microbial communities and identifying root-associated fungi through DNA sequencing

Acknowledgements

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