THE ADDITION of LOCALLY EFFECTIVE MICROBES CHANGES THE COMPOSITION of MICROBIAL COMMUNITIES in BIOCHAR-AMENDED MINE SPOILS

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WHY MINES?

- 100,000 abandoned mines in the western US
- 20,000 km of rivers and streams
- Low pH and concentrated metals, typically with little or no organic matter
- Mines are some of the most degraded landscapes
- Very few pathways to remediate mines and mine tailings

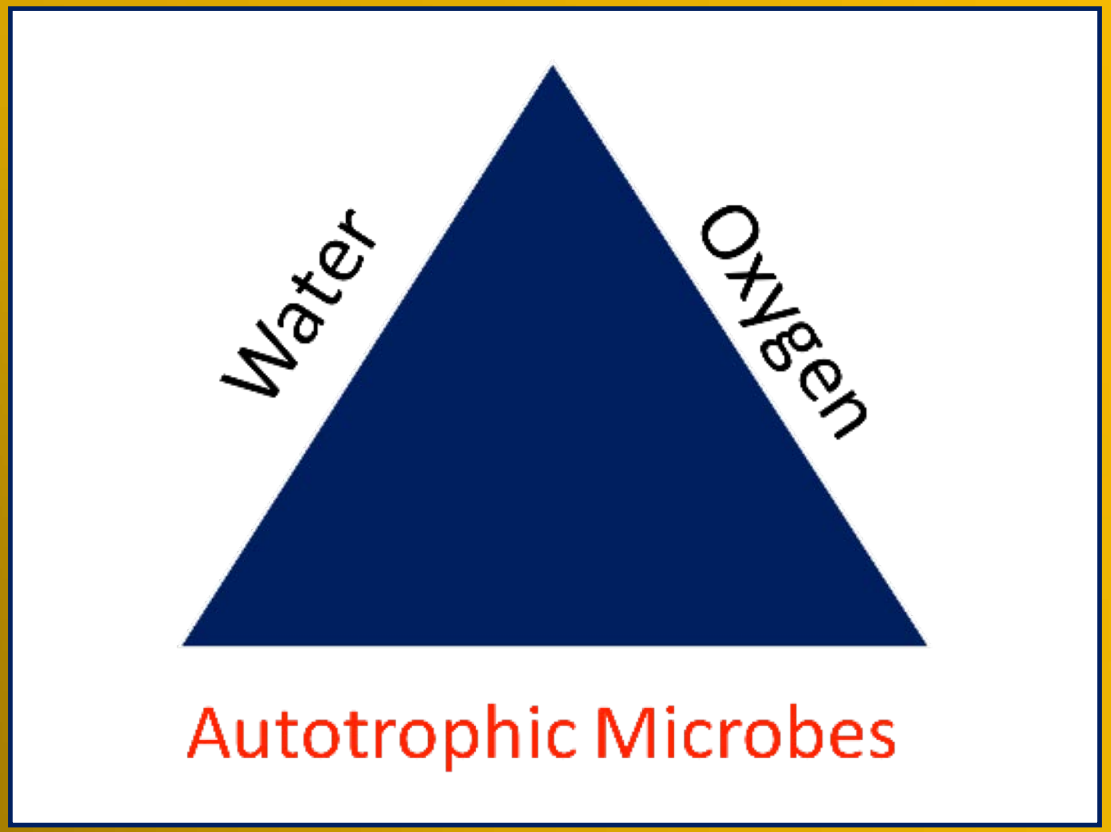
Microbial Communities at Abandoned Mines are Dominated by Bacteria that Interact with the Mineralogy and Perpetuate Acidic Soil Conditions

Abiotic: $FeS_2 + H_2O + 3.5O_2 \rightarrow Fe^{2+} + 2SO_4^{2-} + 2H^+$

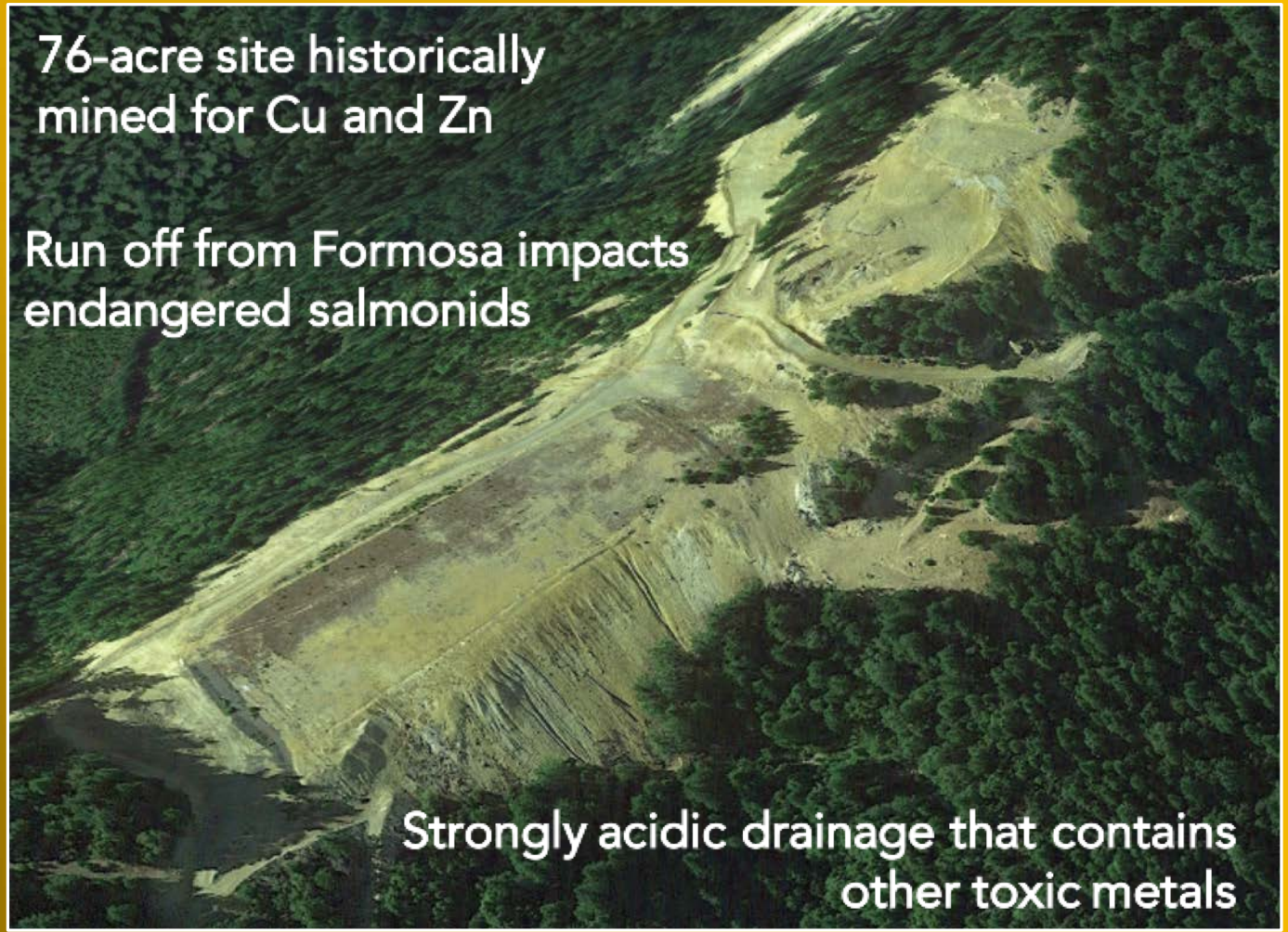
Biotic: $14 \quad + 3.5O_2 + 14H^+ \rightarrow 14Fe^{3+} + 7H_2O$

Abiotic: $FeS_2 + H_2O + \quad \rightarrow 15Fe^{2+} + 2SO_4^{2-} + 16H^+$

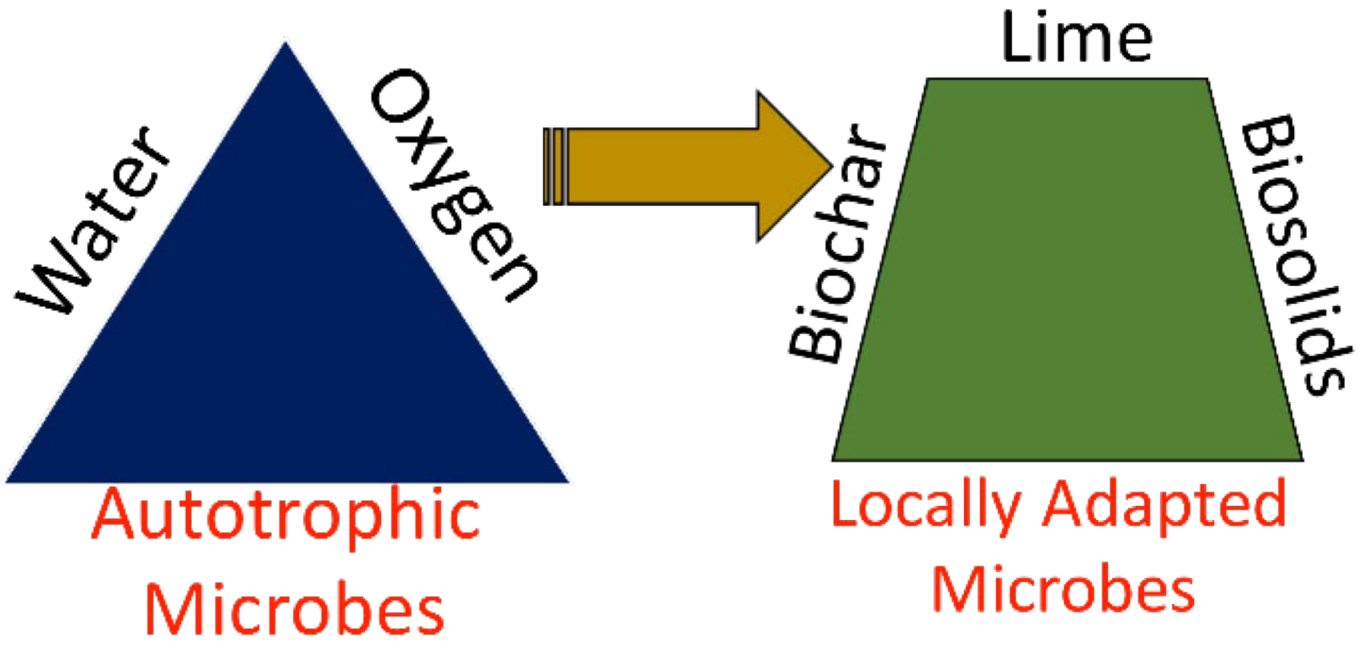
WHY IS REMEDIATION OF MINE SITES *so* DIFFICULT?



PHYTOSTABILIZATION of the FORMOSA MINE

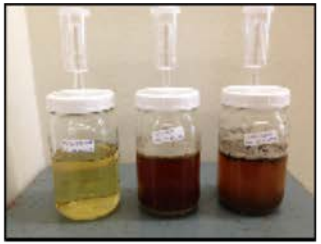


PROPOSED REMEDIATION of FORMOSA

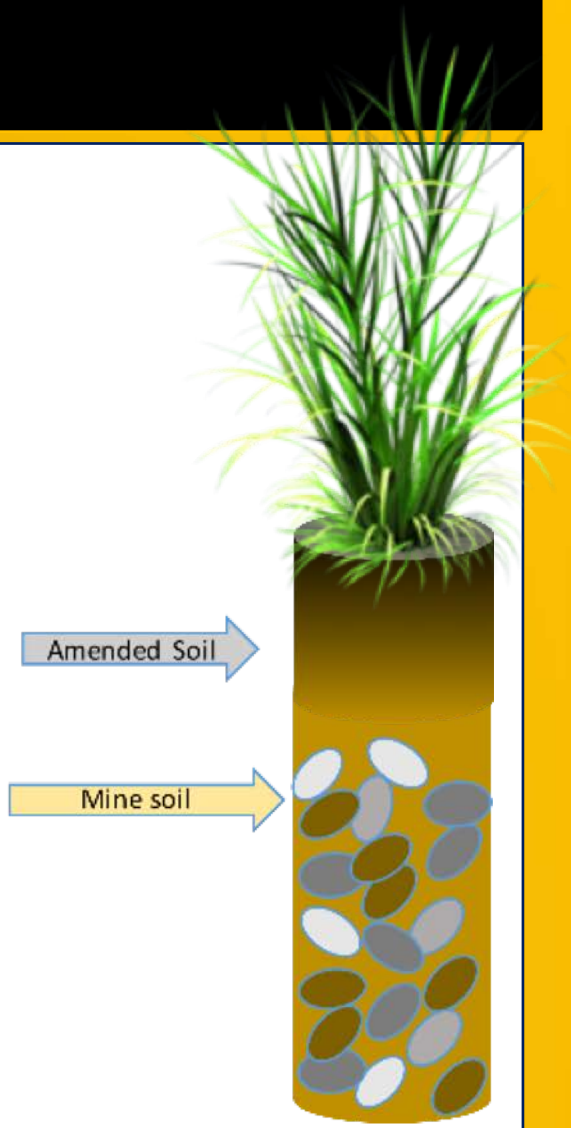


Can we use locally available products to assist the phytostabilization of mines?

Experimental Design

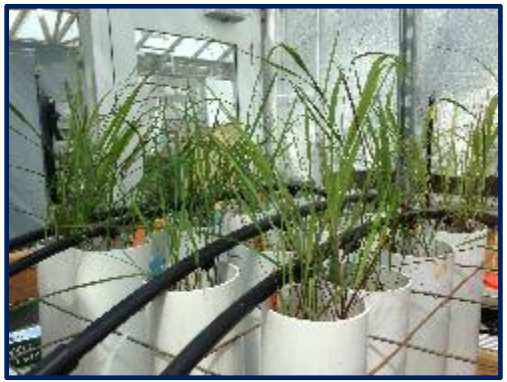


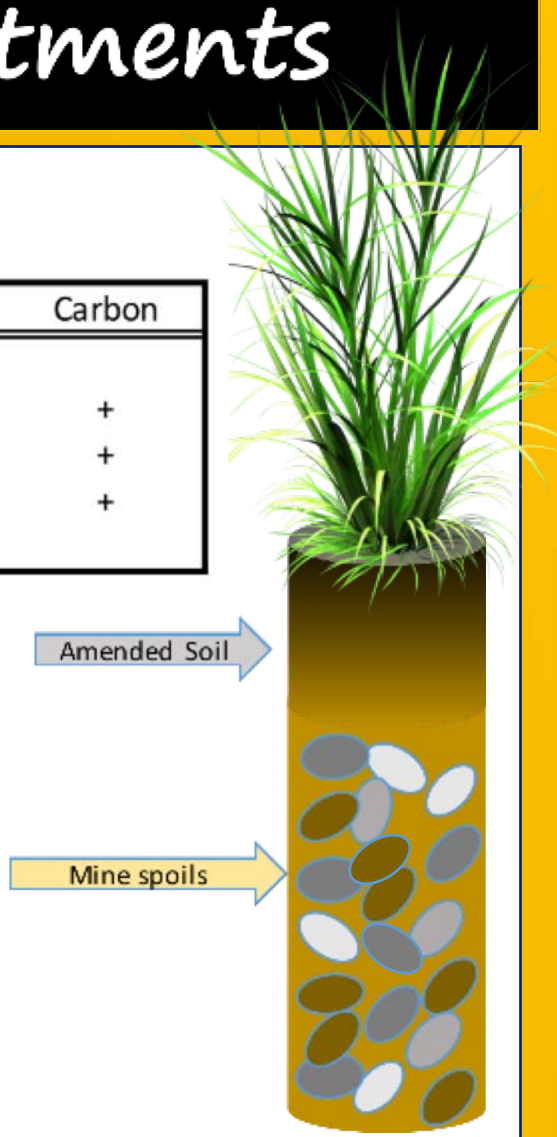
- Collect soil (2-10cm) from forest and mine sites
- Culture locally adapted effective microbes (14 d)
- Ferment cultured microbes with biochar, biosolid mix (80:20) = LEM (14 d)
- Fill 2/3 of PVC cylinder with mine soil
- Top 10 cm soil all treatments mixed with1% lime
- Top 10 cm soil no LEM or 5% false, mine, or forest LEM (30 d)
- Plant with native rye grass (112 d)



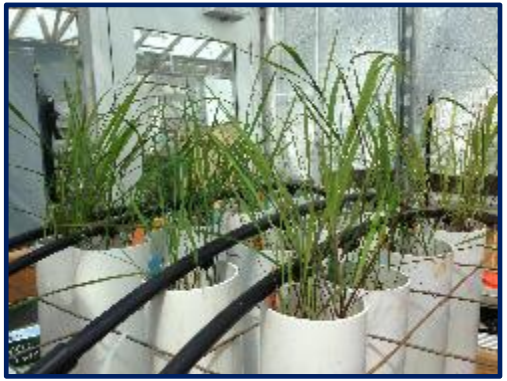
Experimental Design: Treatments

Treatment	Lime	Biochar	Biosolids	Microbes	pH	Carbon
Lime	1%	X	X	X	5.9	
False LEM	1%	4%	1%	X	6.1	+
Forest LEM	1%	4%	1%	Forest	6.1	+
Mine LEM	1%	4%	1%	Mine	6.1	+
SPOILS	X	X	X	X	3.1	





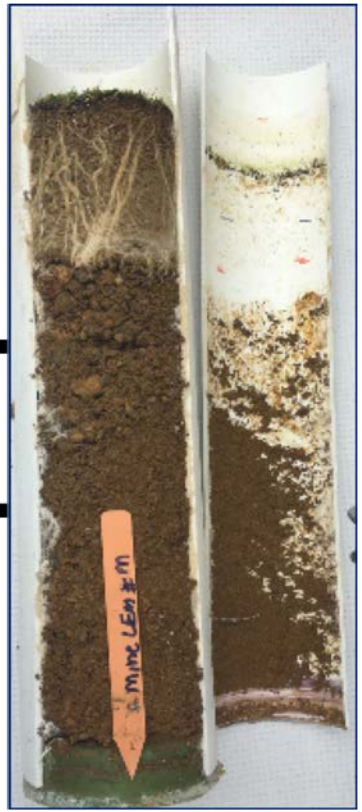
Experimental Design: measurements



- Above ground/below ground biomass
- **PLFA**
- **Illumina 16S/LSU**
- Soil Enzyme Activities
- SIR
- **Total C,N**
- **Plant available metals, macronutrients**
- **pH** and EC

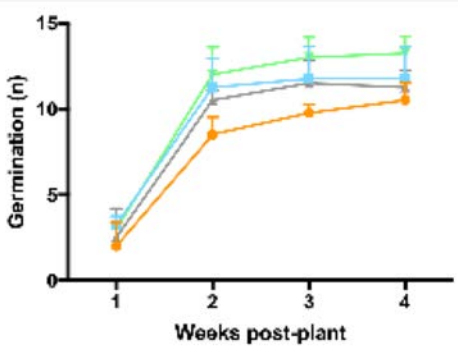
Rhizosphere
Root Associated

Mine
Spoils



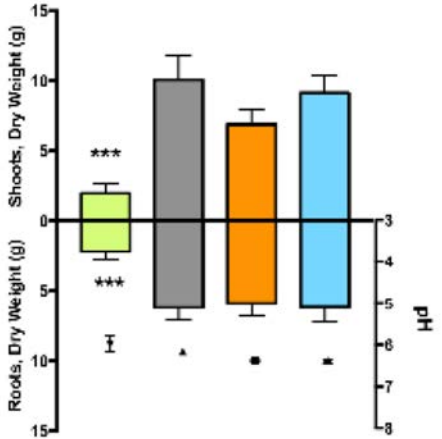
BIOCHAR and BIOSOLID AMENDMENTS PROVIDE *an advantage* OVER LIME

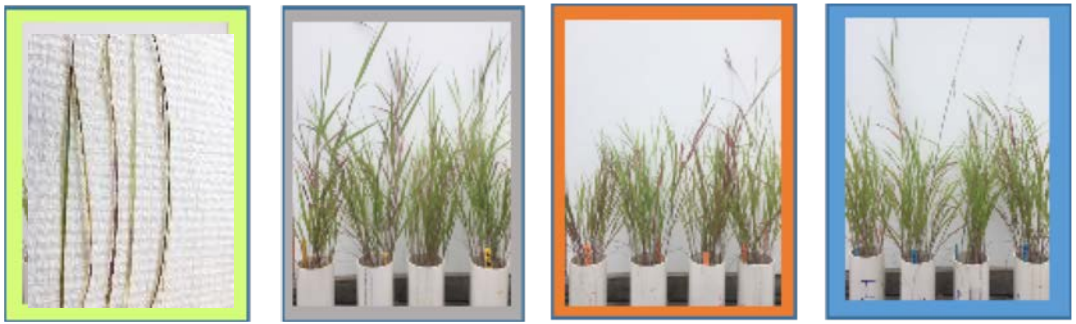
Germination



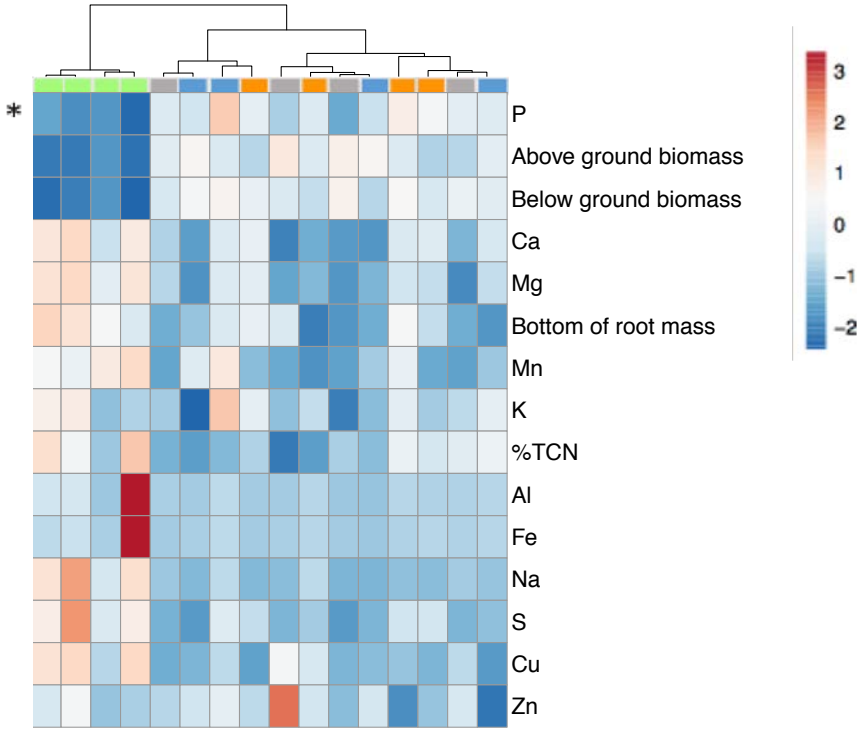
Lime
Mine LEM
Forest LEM
False LEM

Plant biomass

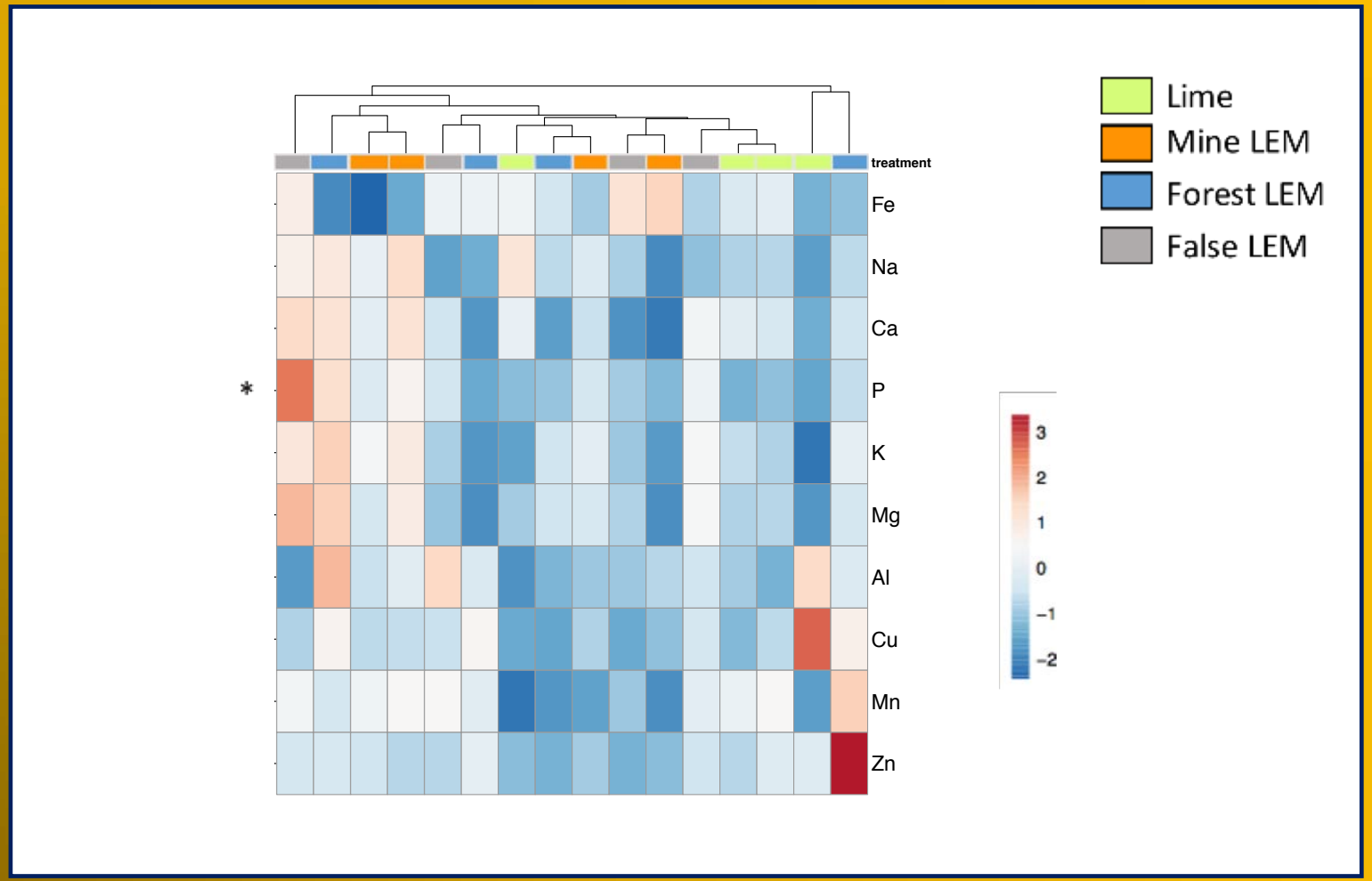




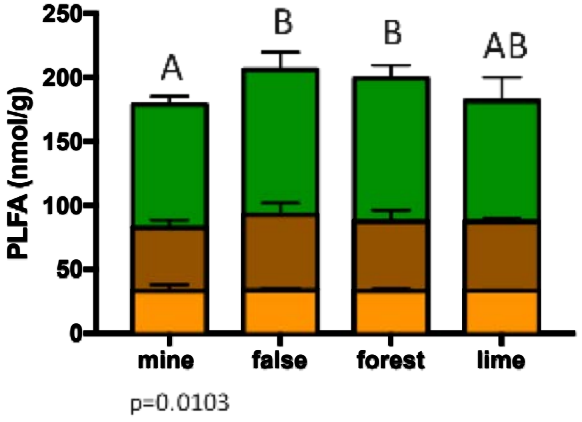
Plant Growth Metrics and Chemistry



Soil Chemistry (root associated soil)

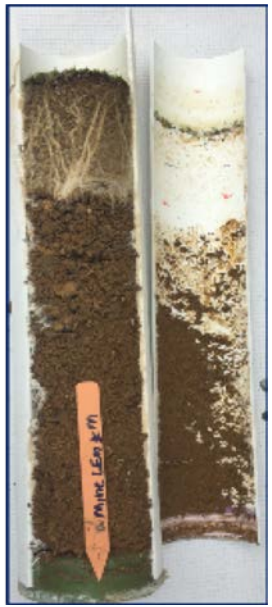


Microbial biomass in rhizosphere differs

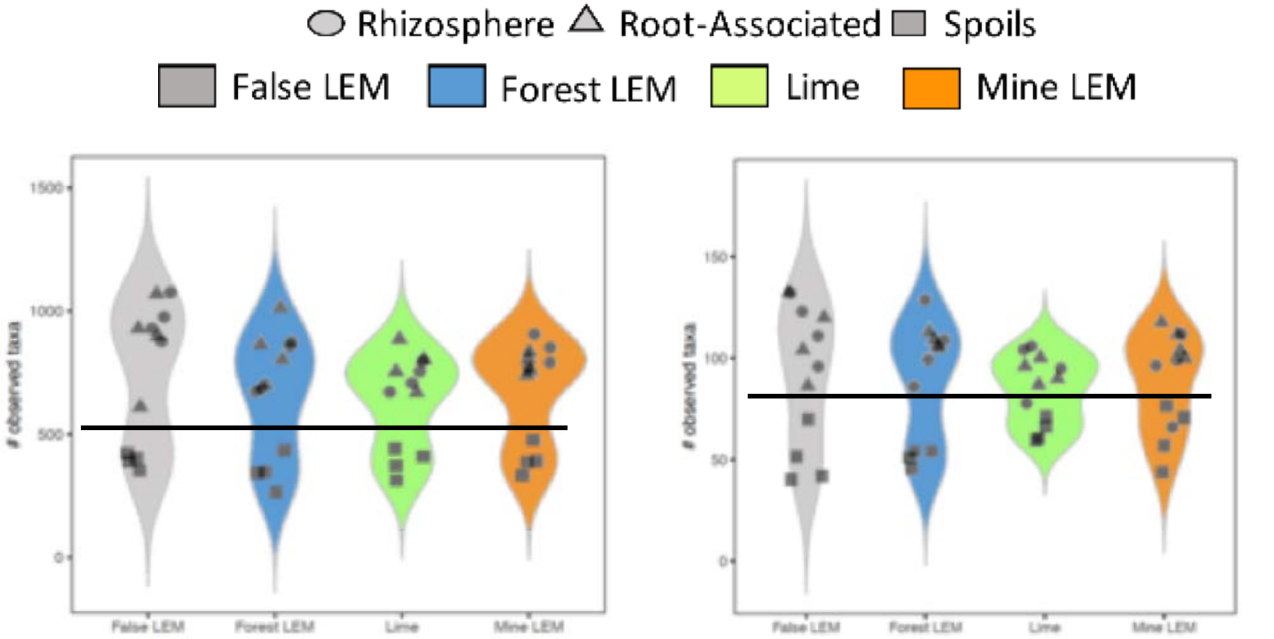


Rhizosphere
Root associated

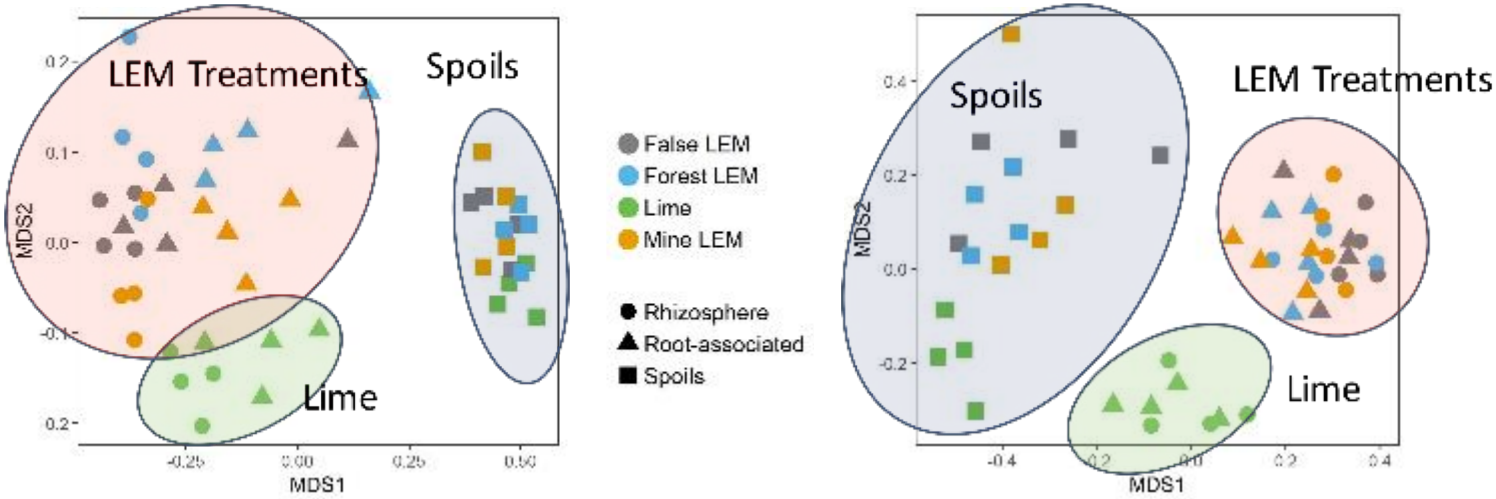
Mine
Spoils



Microbial diversity is increased in soils with increased pH



Soil characteristics drive the composition of microbial communities

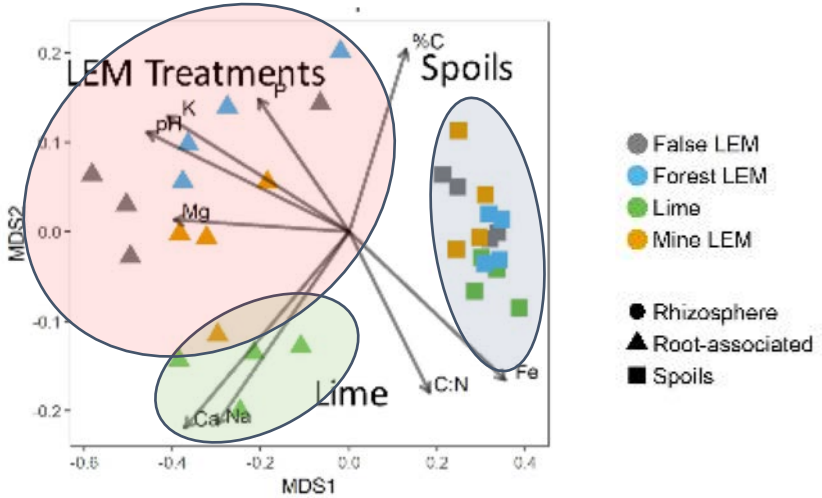


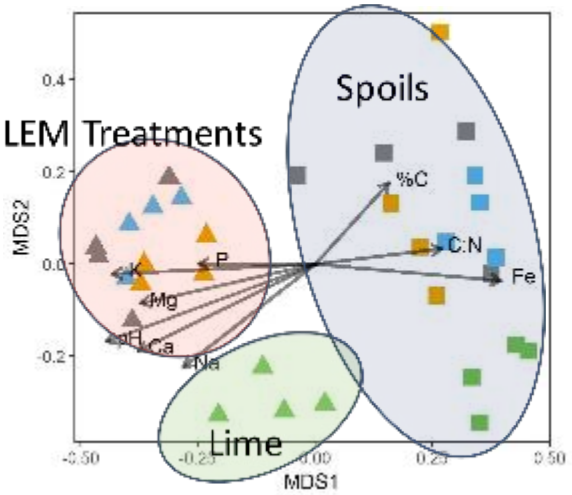
Bacterial Communities

Fungal Communities

BASED ON pH AND SOIL NUTRIENTS, THESE RESULTS ARE PREDICTED!

Soil characteristics drive the composition of microbial communities



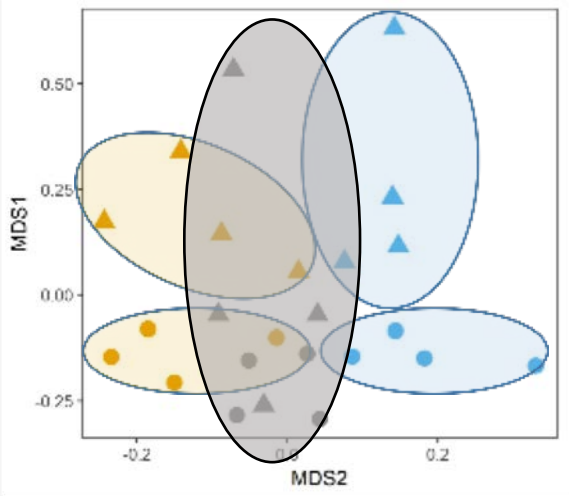


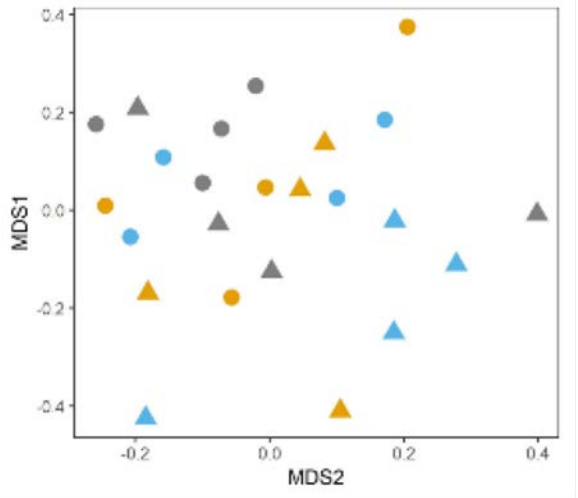
Bacterial Communities

Fungal Communities

BASED ON pH AND SOIL NUTRIENTS, THESE RESULTS ARE PREDICTED!

The addition of LEM *drives* changes in the microbial community.





Bacterial Communities

Statistically differ by treatment and soil type ($p<0.001$)

Fungal Communities

CONCLUSIONS *and* FUTURE DIRECTIONS

- The addition of biochar/biosolids increases plant biomass
- The microbes from the LEM do not appear to change community composition of the mine spoils
- The plants grown in LEM recruit specific microbes to the rhizosphere
- This recruitment likely influences plant growth and establishment
- Refining our techniques to inoculate our field study with site-specific taxa

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