# UPDATE ON RECLAMATION AND REMEDIATION ACTIVITIES UTILIZING BIOCHAR

Andrew Harley, PhD


July 2010
FOR 60 YEARS IT LOOKED LIKE THIS...
August 2011
NOW IT LOOKS LIKE THIS
www.biocharreclamation.com ®

DURAROOT

# BIOCHAR


- Charcoal used for particular purposes, especially as a soil amendment. Like all charcoal, biochar is created by pyrolysis of biomass.
- Biochar is a stable solid, rich in carbon and can endure in soil for thousands of years.
- Biochar is proposed as an approach to carbon sequestration to reduce carbon dioxide emissions.
- Independently, biochar can increase soil fertility, increase agricultural productivity and provide protection against some foliar and soil-borne diseases.

# BIOCHAR

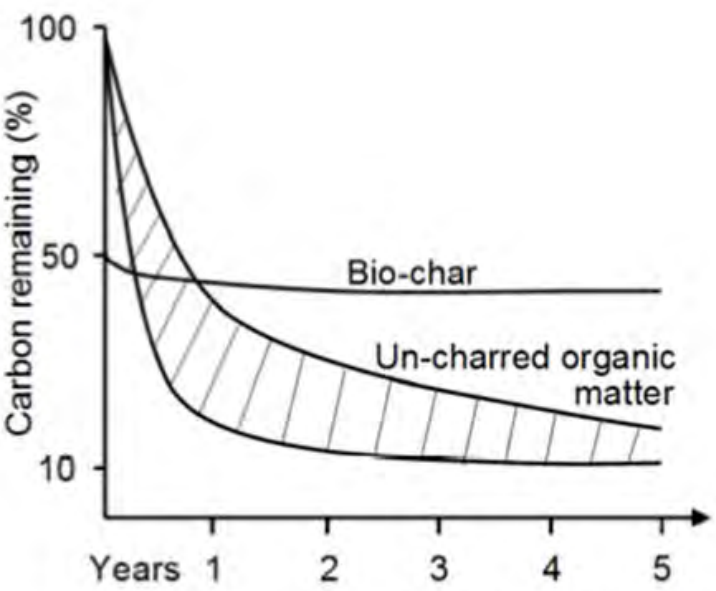


*Figure from Professor Johannes Lehmann et al, 2006, Mitigation and Adaptation*

# RECLAMATION

# HOPE MINE
## WHITE RIVER NF

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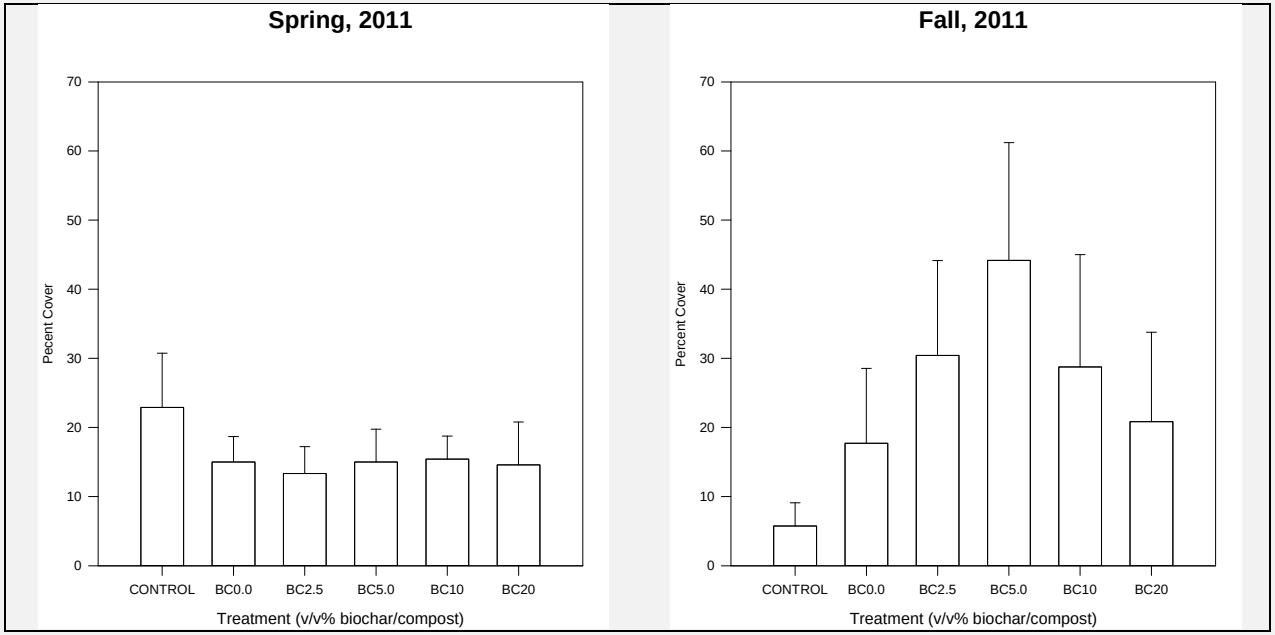

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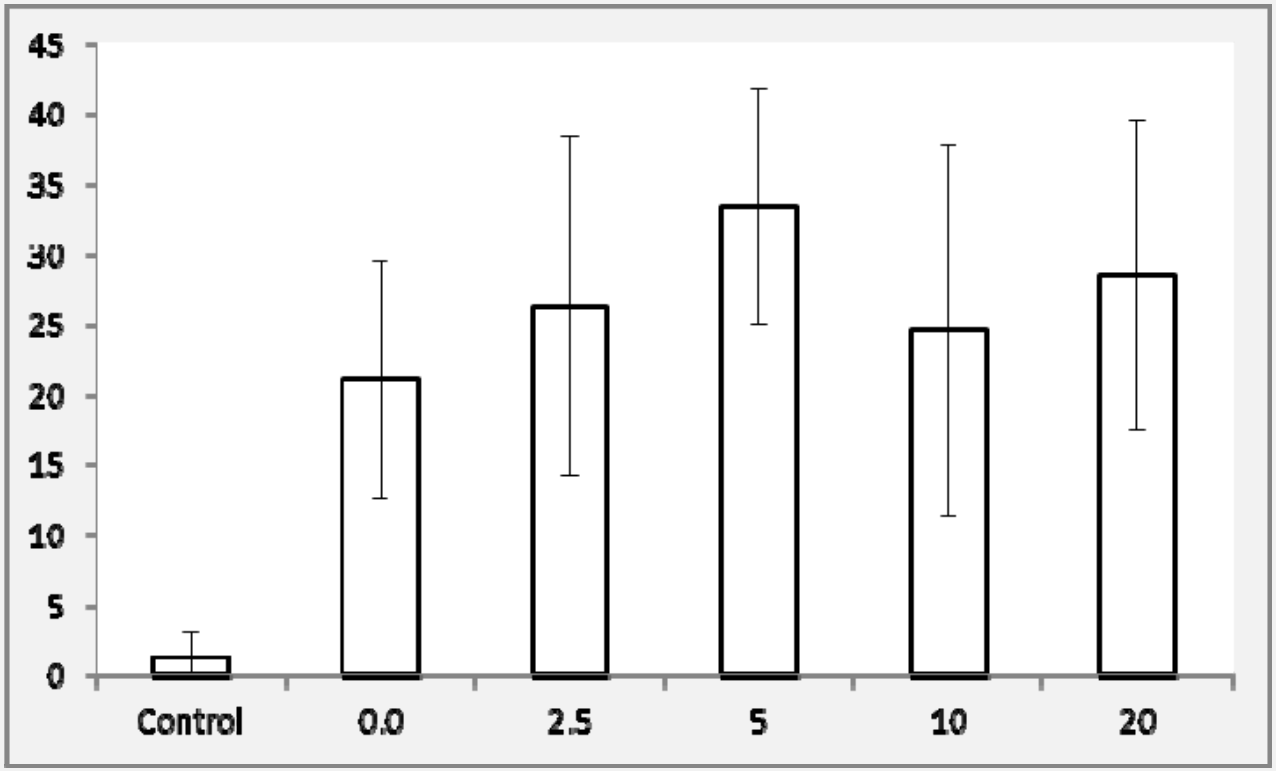
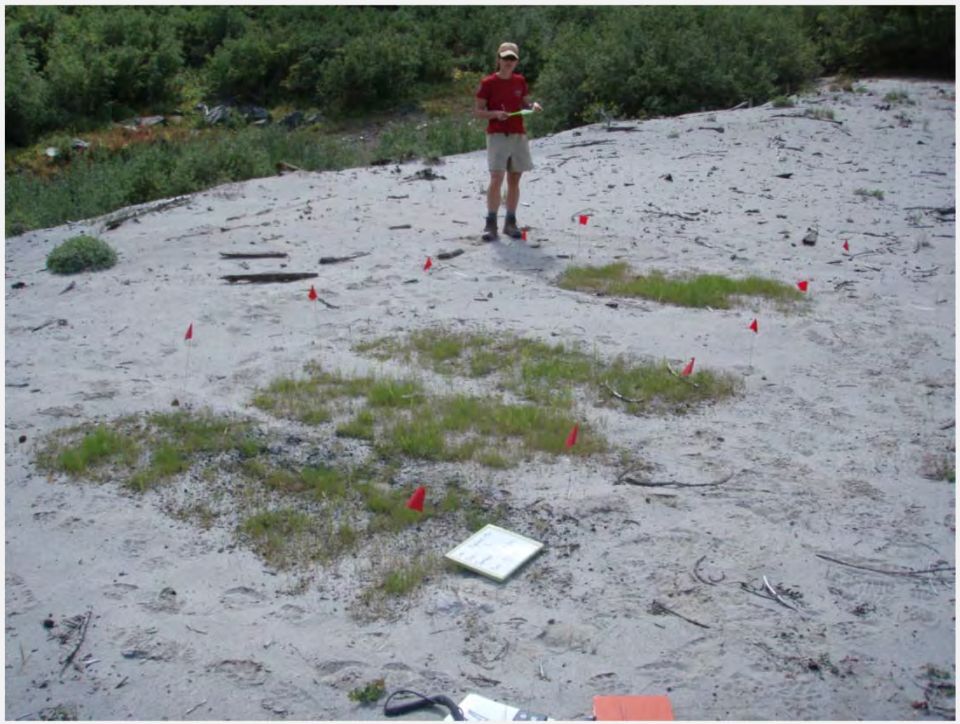


# SAN JUAN PUBLIC LANDS

CHRIS PELTZ, RESEARCH SERVICES, LLC



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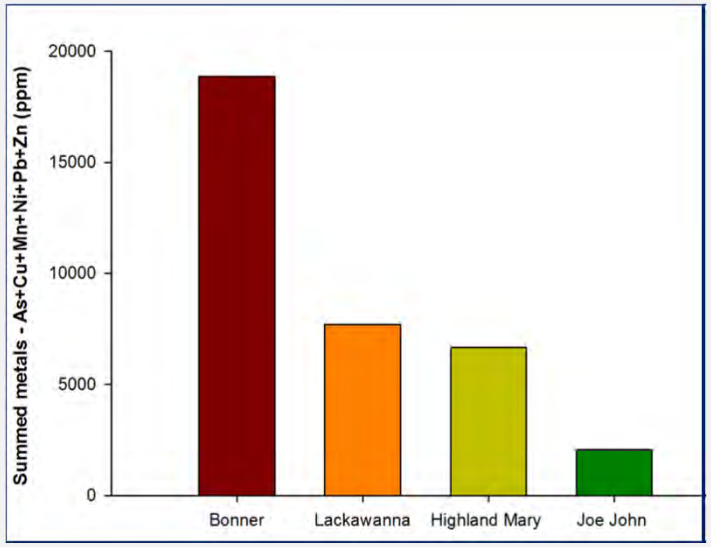


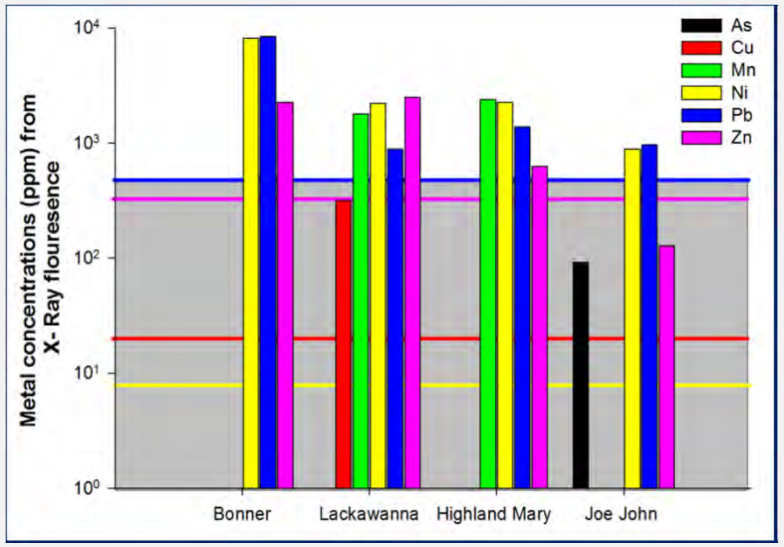


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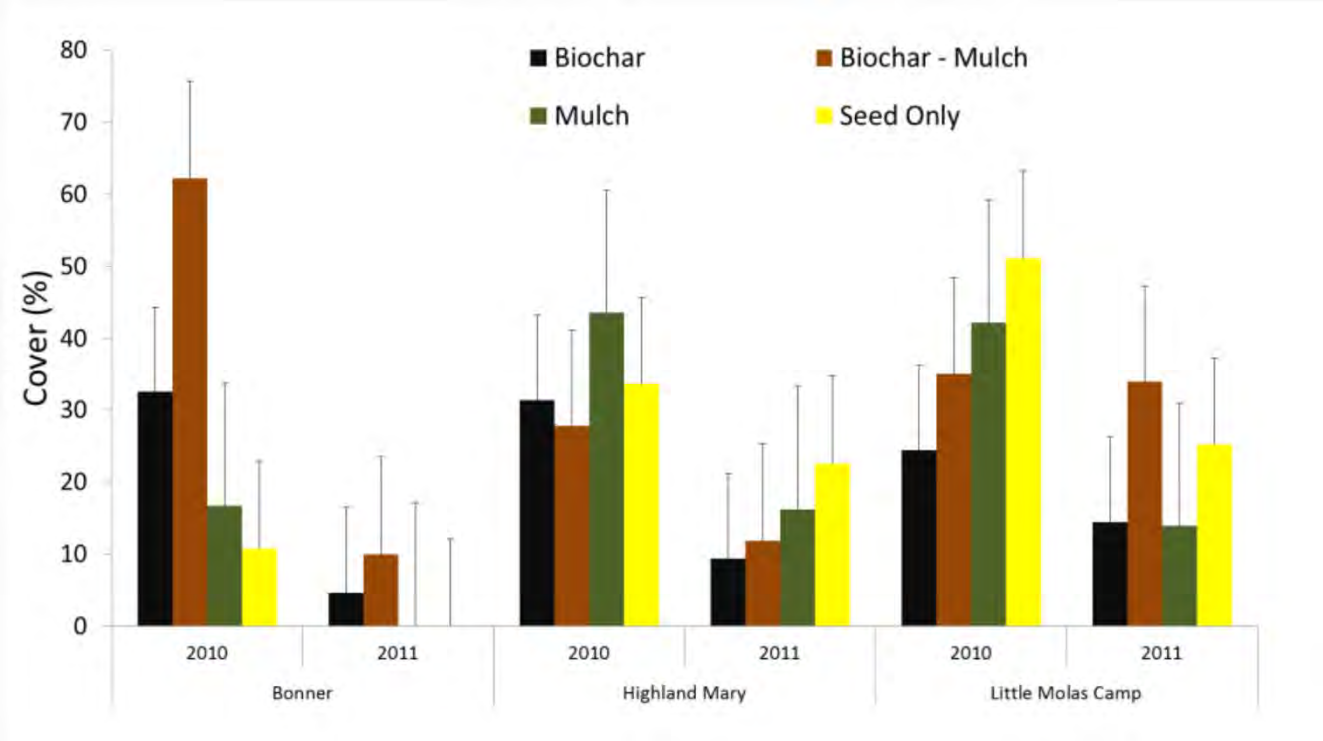

# RUBY HILL MINE -EUREKA, NV

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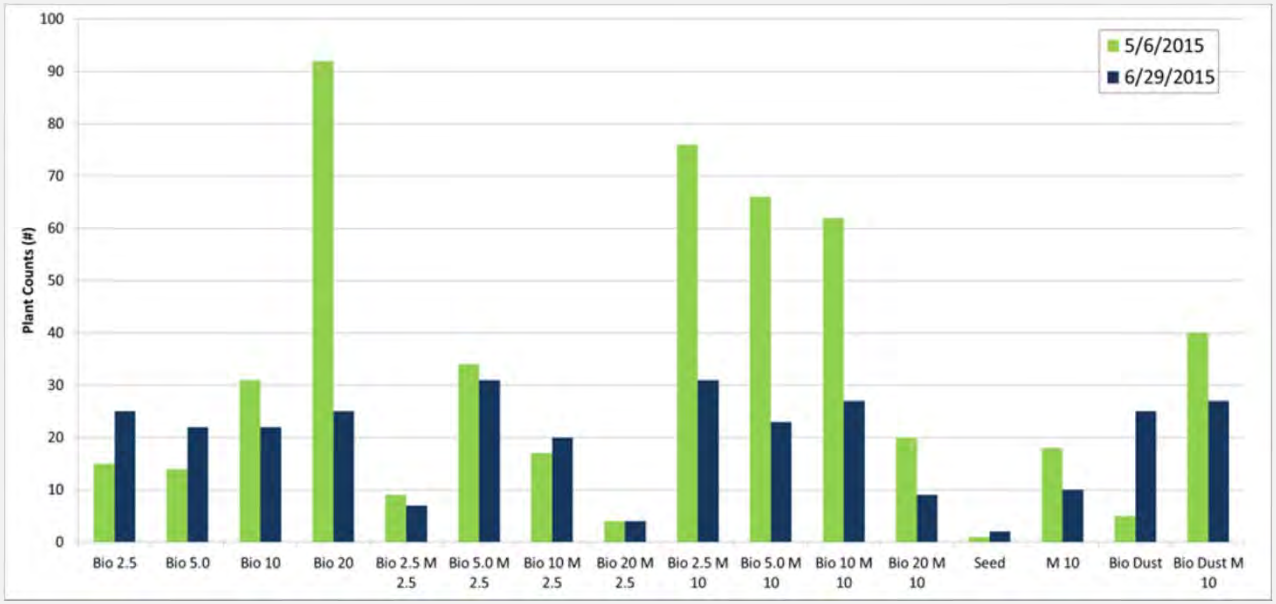
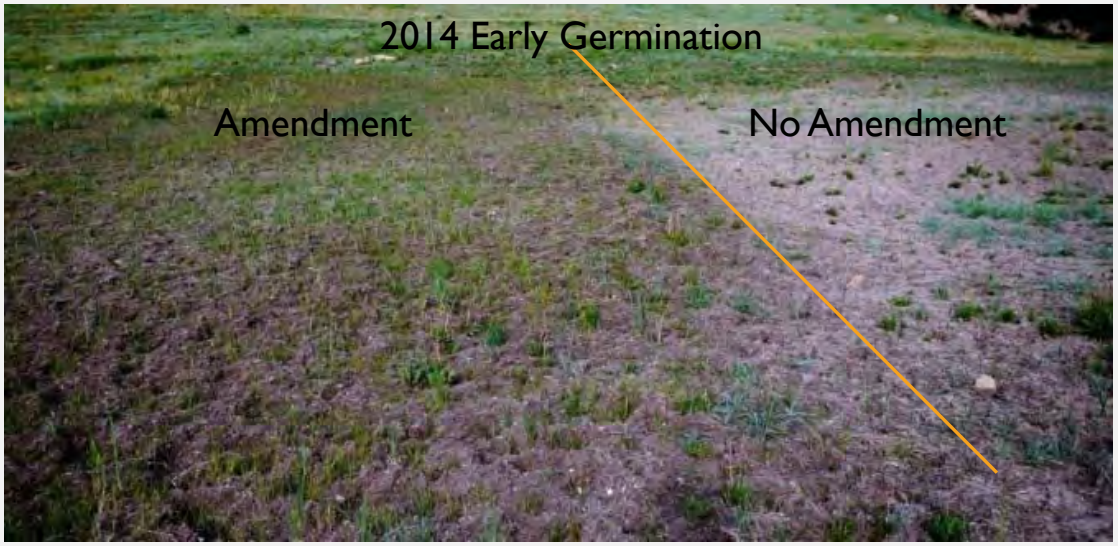


# COAL BASIN SUTEY PILE

WHITE RIVER NATIONAL FOREST, BRIAN McMULLEN, WAYNE IVES



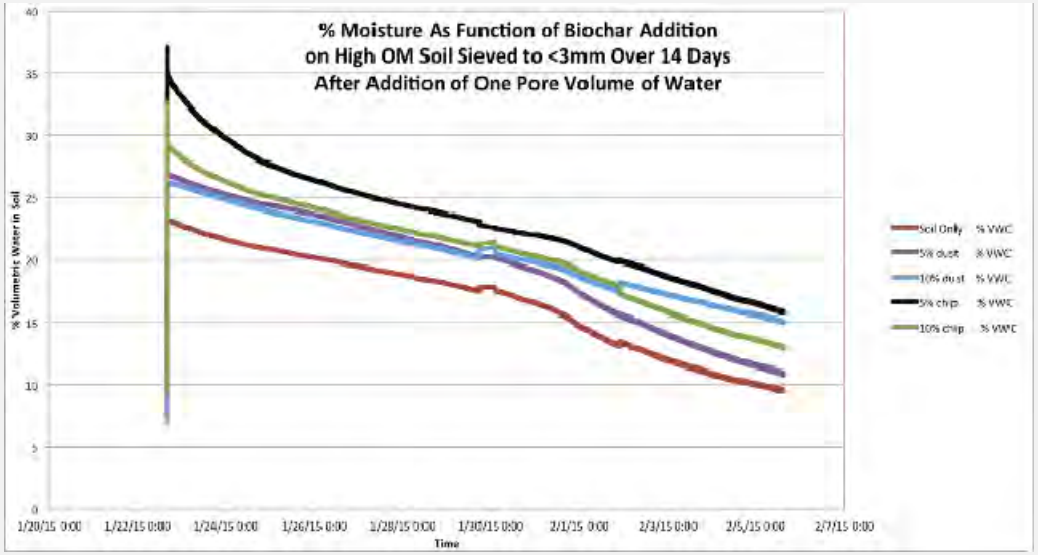
# DOCTOR MINE TAILINGS/WETLANDS

## ARAPAHO NF, TREZ SKILLERN

# WATER CONTENT

# MOISTURE CHARACTERISITIC TRIALS

MORGAN WILLIAMS, APPLIED SOILS; JONAH LEVINE
CONFLUENCE ENERGY



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WHITE RIVER NF, BRIAN McMULLEN

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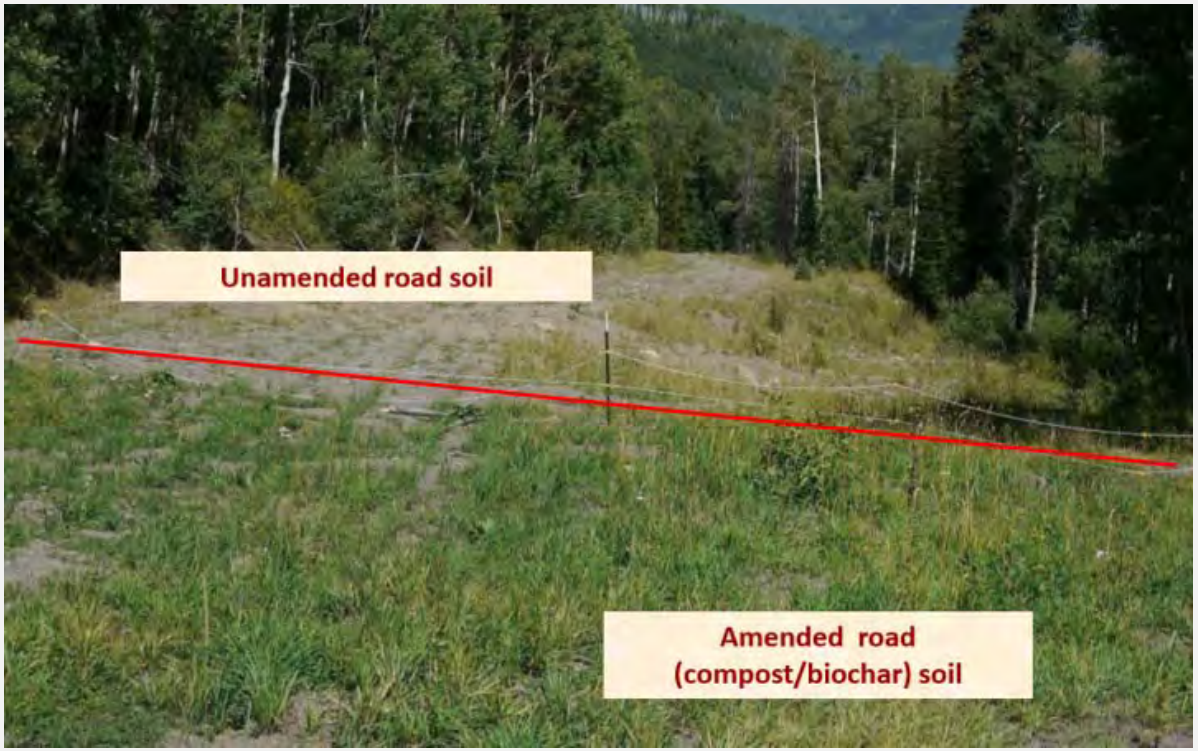

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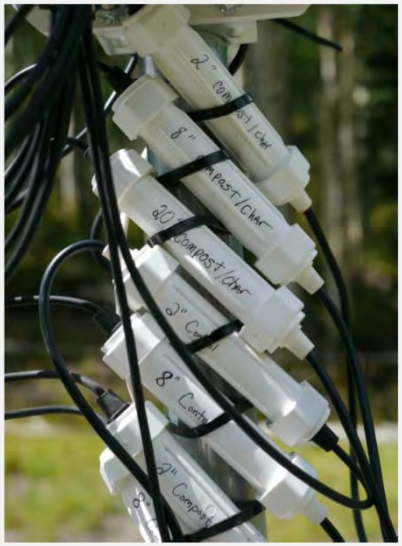


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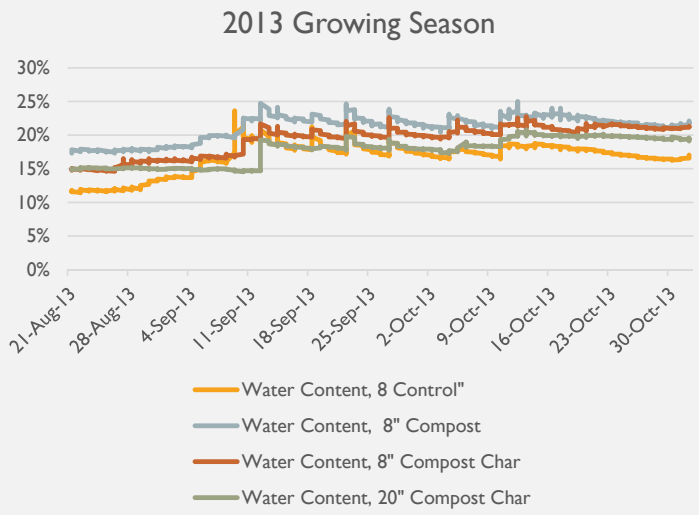


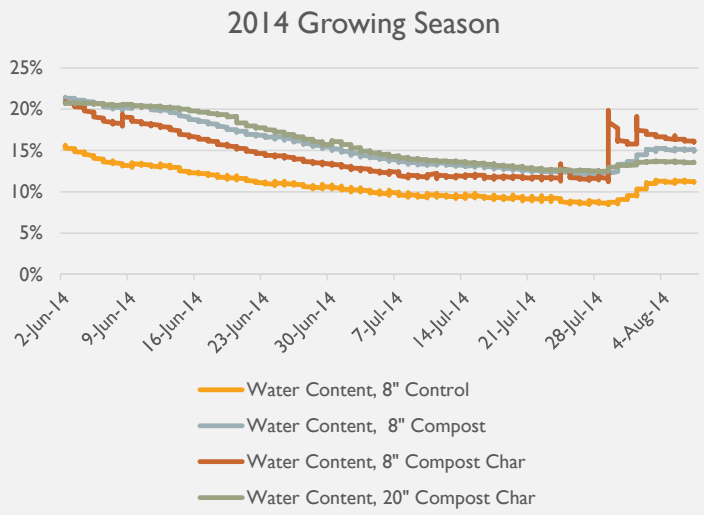

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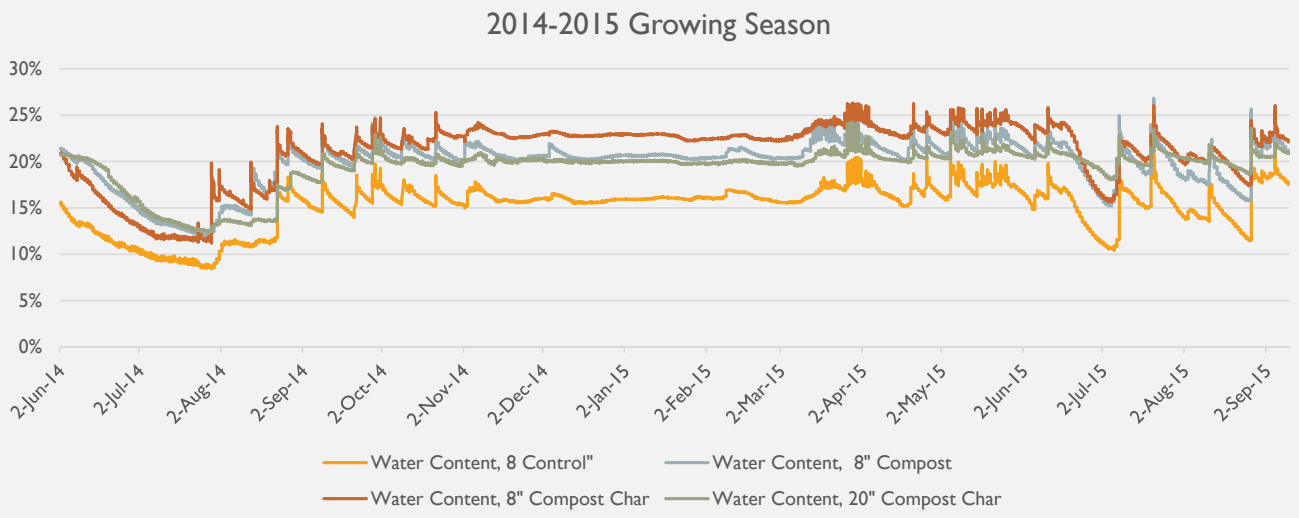

# UMATILLA NATIONAL FOREST

DEB DUMROESE, ROCKY MOUNTAIN RESEARCH STATION

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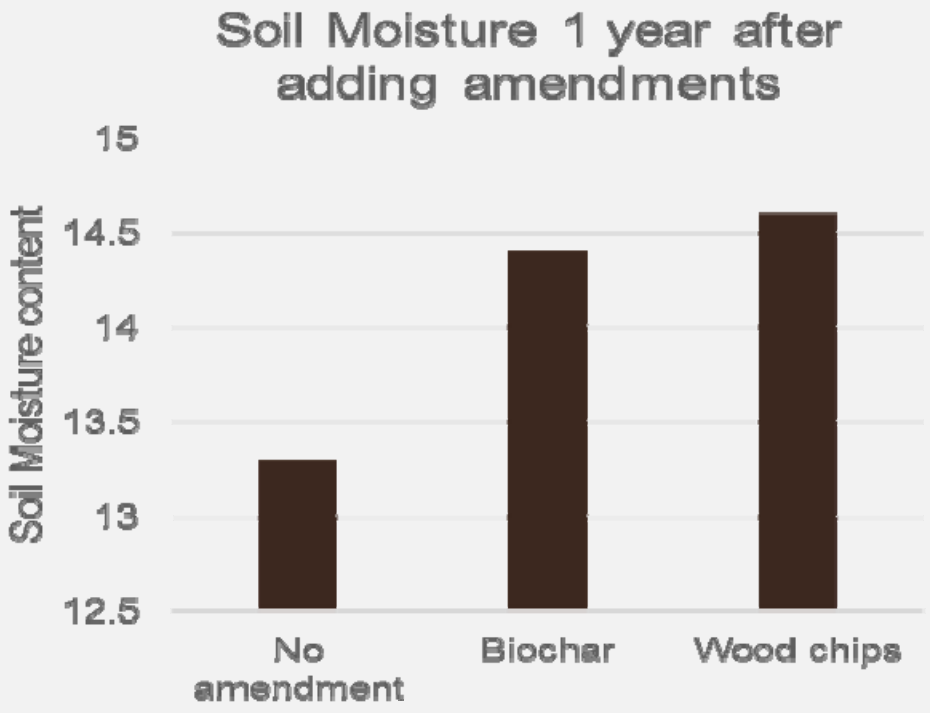
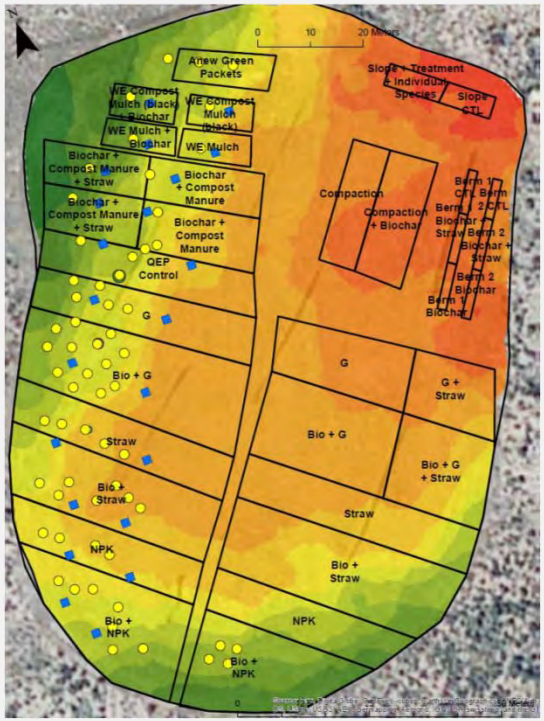


# UTAH STATE BIOMASS RESOURCE GROUP/QEP RESOURCES BIOCHAR TRIALS

CHRIS PELTZ, RESEARCH SERVICES, LLC



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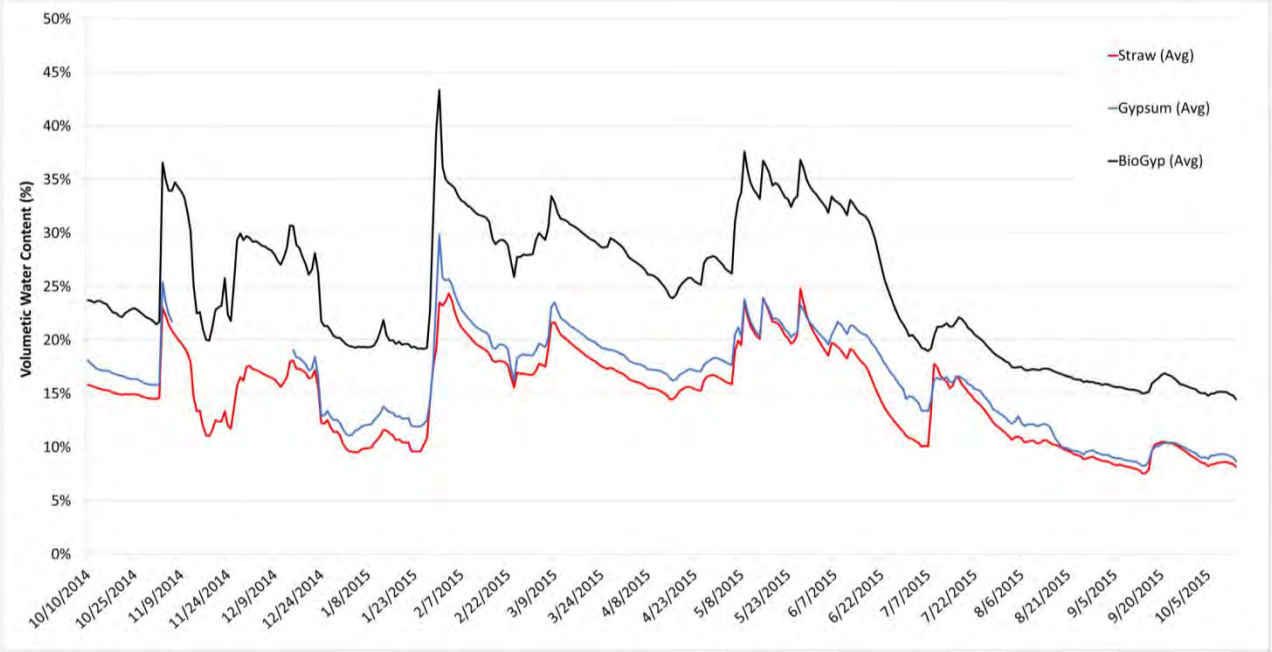

# METAL REMEDIATION

# METAL SORPTION

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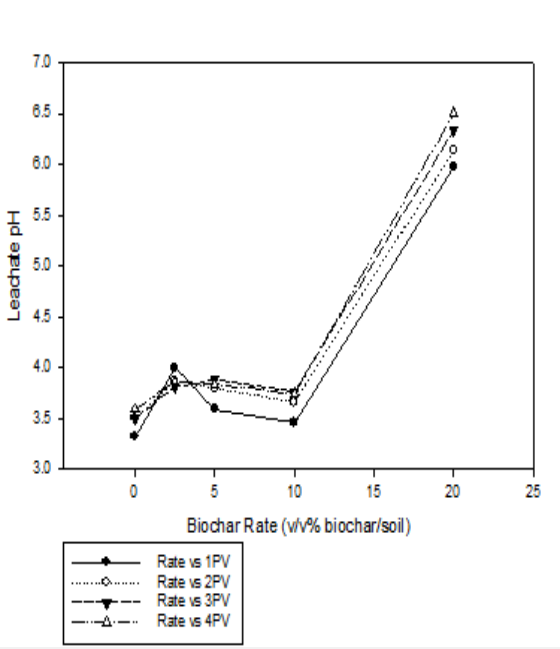
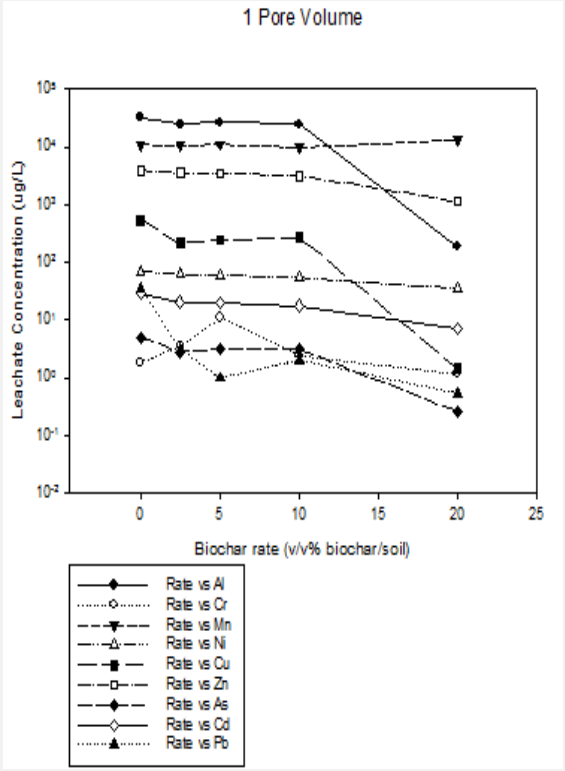
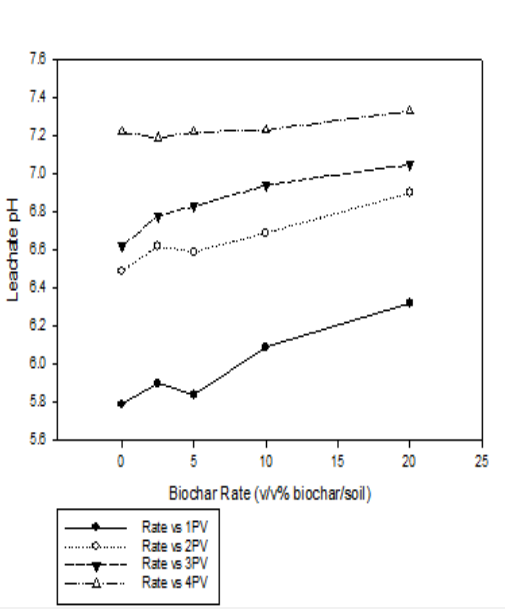
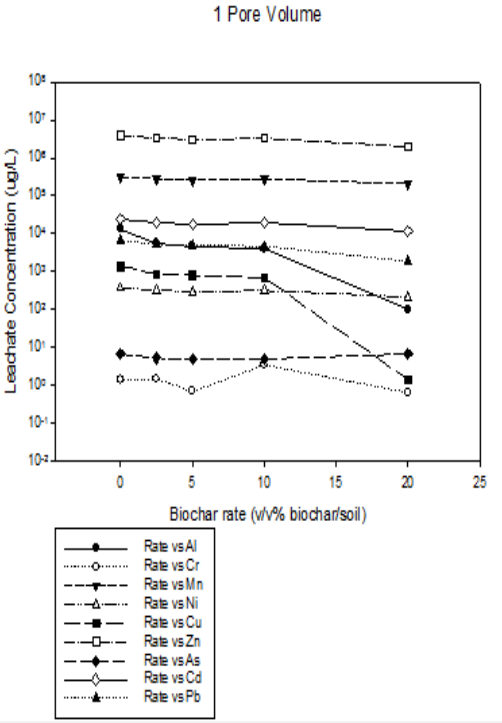
## ACIDIC MINE WASTE



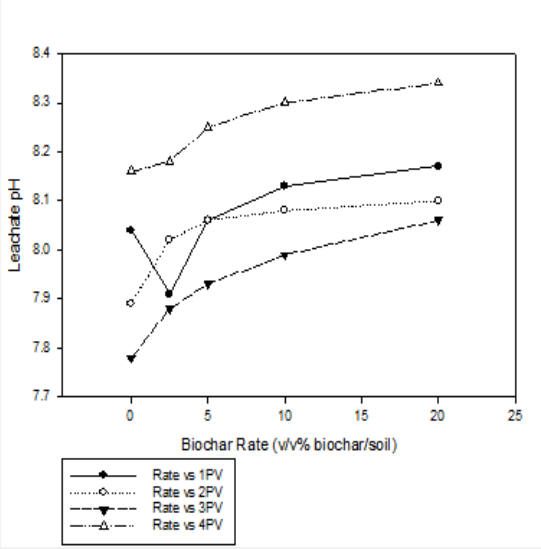



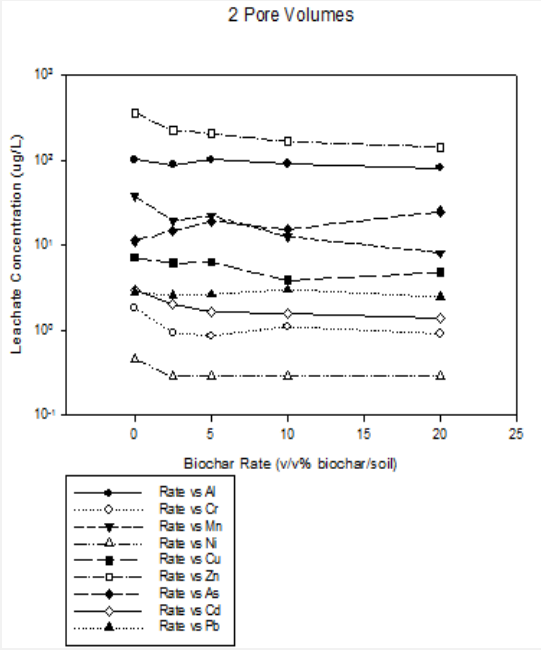
# METAL SORPTION
## CIRCUMNEUTRAL MINE WASTE



# METAL SORPTION – ALKALINE (CARBONATE) MINE WASTE



# HEAVY METAL SEQUESTRATION

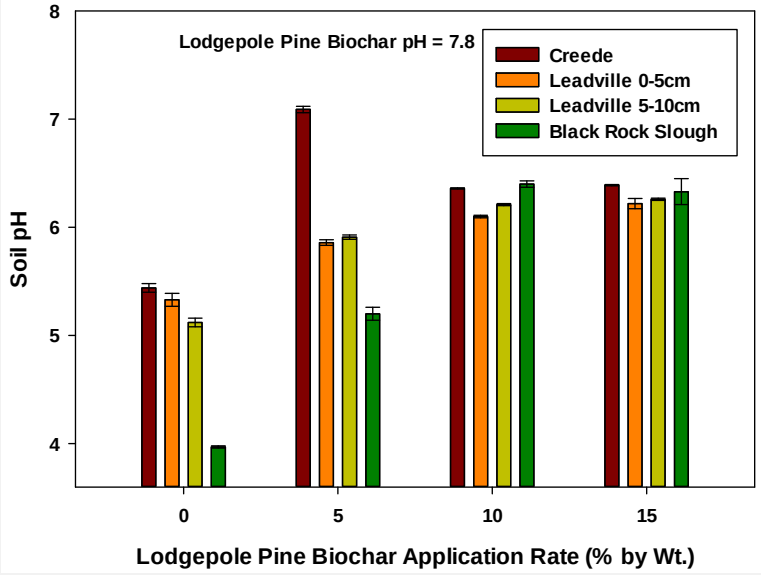
## JIM IPPOLITO, NORTHWEST IRRIGATION & SOILS RESEARCH LABORATORY

- Soils from:
  - Leadville, Colorado (Cd, Cu, Mn, Zn); 0-5 and 5-10cm depths
  - Creede, Colorado (Cd, Cu, Mn, Pb, Zn)
  - Black Rock Slough in Northern Idaho (Mn, Pb, Zn)
- Feedstocks: Lodgepole pine, tamarisk, switchgrass; 500 °C
- Metal bioavailability test (e.g. plant-availability):
  - 3 g soil:biochar equivalent to 0, 5, 10, and 15% by weight
  - 30 mL 0.01M $CaCl_2$; shake 2 hours; centrifuge.
  - Analyze solution pH; Filter through 0.45 um and analyze heavy metals via ICP-OES.

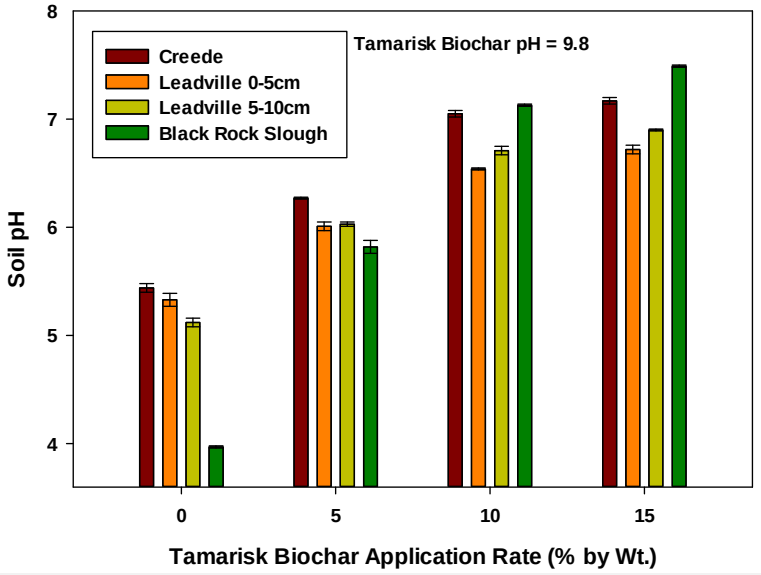
# HEAVY METAL SEQUESTRATION

JIM IPPOLITO, NORTHWEST IRRIGATION & SOILS RESEARCH LABORATORY

**Lodgepole Pine Biochar and Soil pH**




**Tamarisk Biochar and Soil pH**



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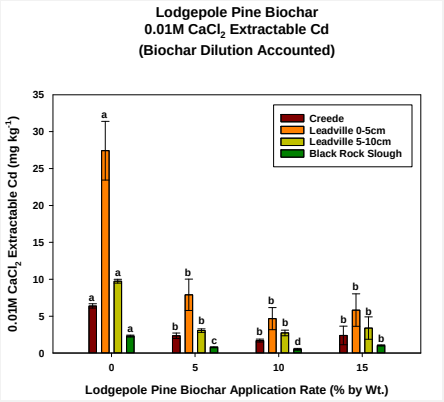


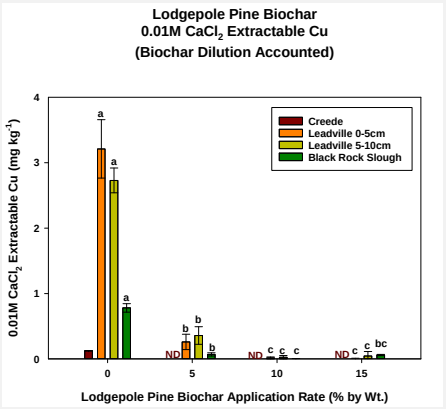


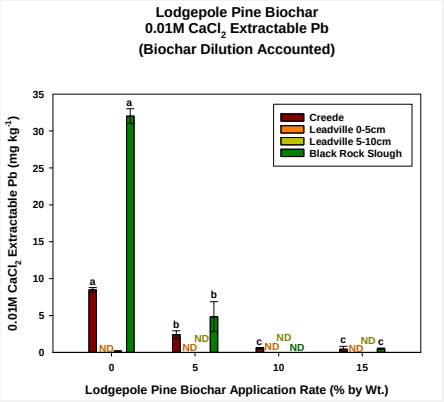


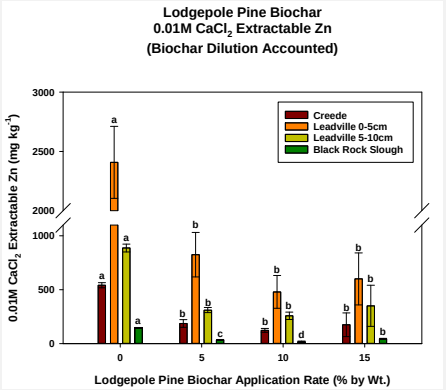

# HEAVY METAL SEQUESTRATION

- Some biochars can cause decreases in plant-available heavy metals
- Knowing the metal binding phase(s) is important for long-term mine land site reclamation
  - Binding to organic functional groups
  - Binding to Fe/Mn oxyhydroxides
  - Precipitation of insoluble carbonates/oxides

# EPA SCREENING BIOCHARS FOR POTENTIAL TO SORB METALS FROM MINE LAND AFFECTED SOILS

- Central OR; Tri-State Mining District
- Mainly Zn, lesser Cd, Cu
- Screened 38 biochars, variety feedstock
- 1,% 2.5%, 5% w/w, followed by SPLP
- SPLP
- 13/38 reduced Zn concentrations
- 7/13 did not re-release Zn
- Currently doing greenhouse trials

# WATER TREATMENT

# SAN JUAN PUBLIC LANDS

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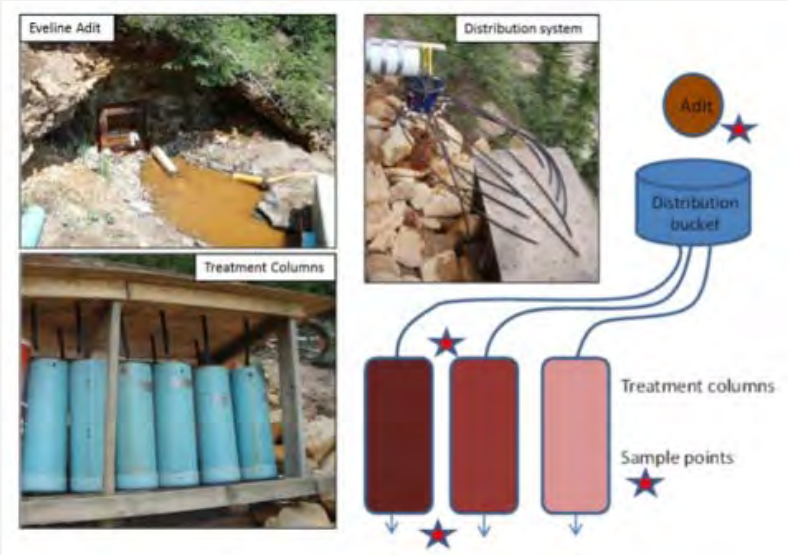

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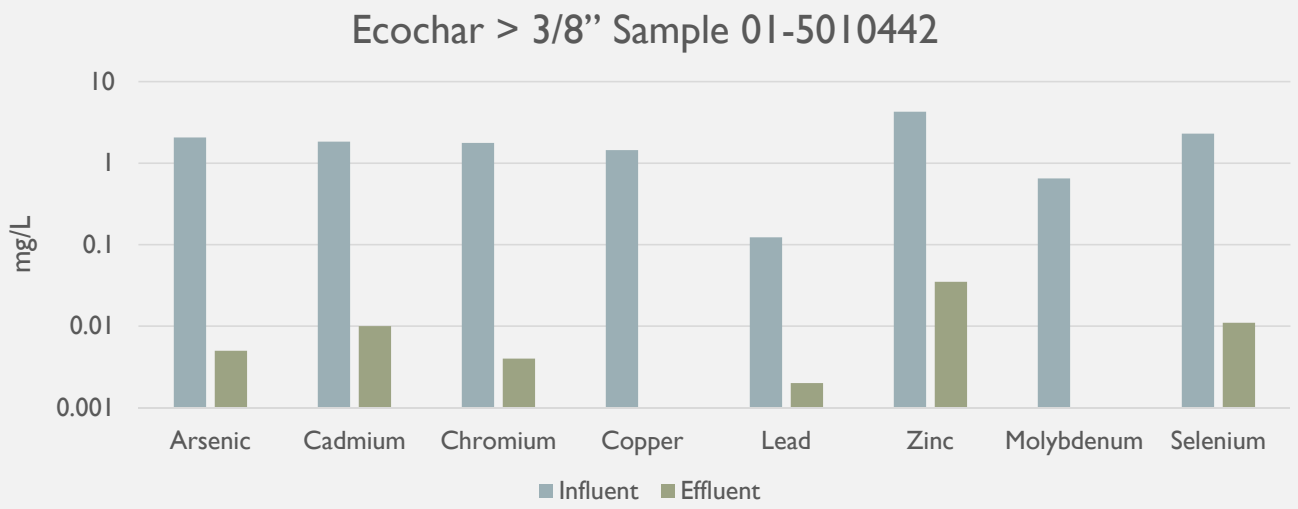
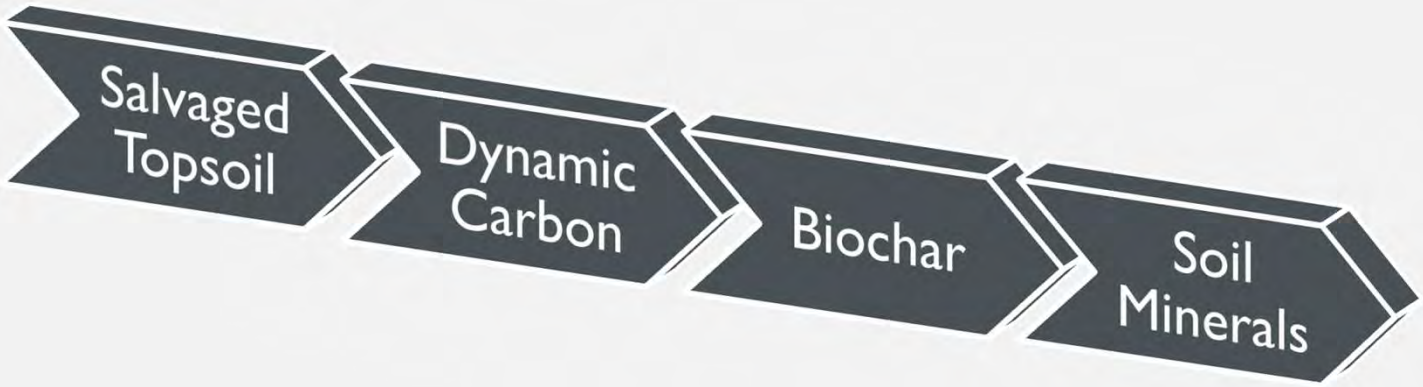
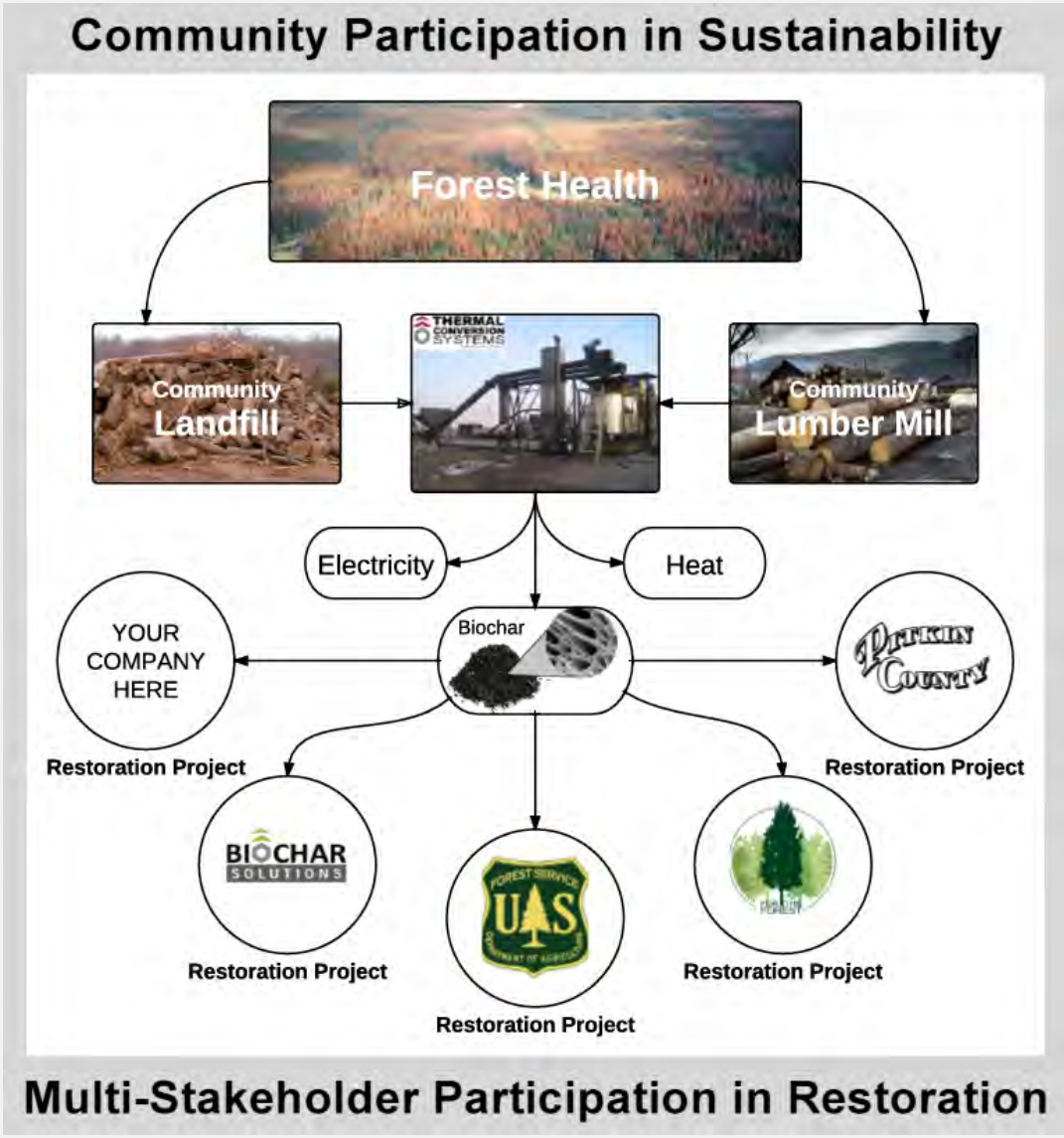



Salvaged Topsoil
Dynamic Carbon
Biochar
Soil Minerals


Community Participation in Sustainability
Forest Health
Community
Landfill
THERMAL CONVERSION SYSTEMS
Community
Lumber Mill
Electricity
Heat
YOUR COMPANY HERE
Biochar
Restoration Project
Restoration Project
BIOCHAR SOLUTIONS
Restoration Project
Restoration Project
Restoration Project
Multi-Stakeholder Participation in Restoration