Building Soil Organic Matter with Biochar: What are the connections between carbon sequestration and soil health? *(and what are some opportunities for use in the forestry sector?)*

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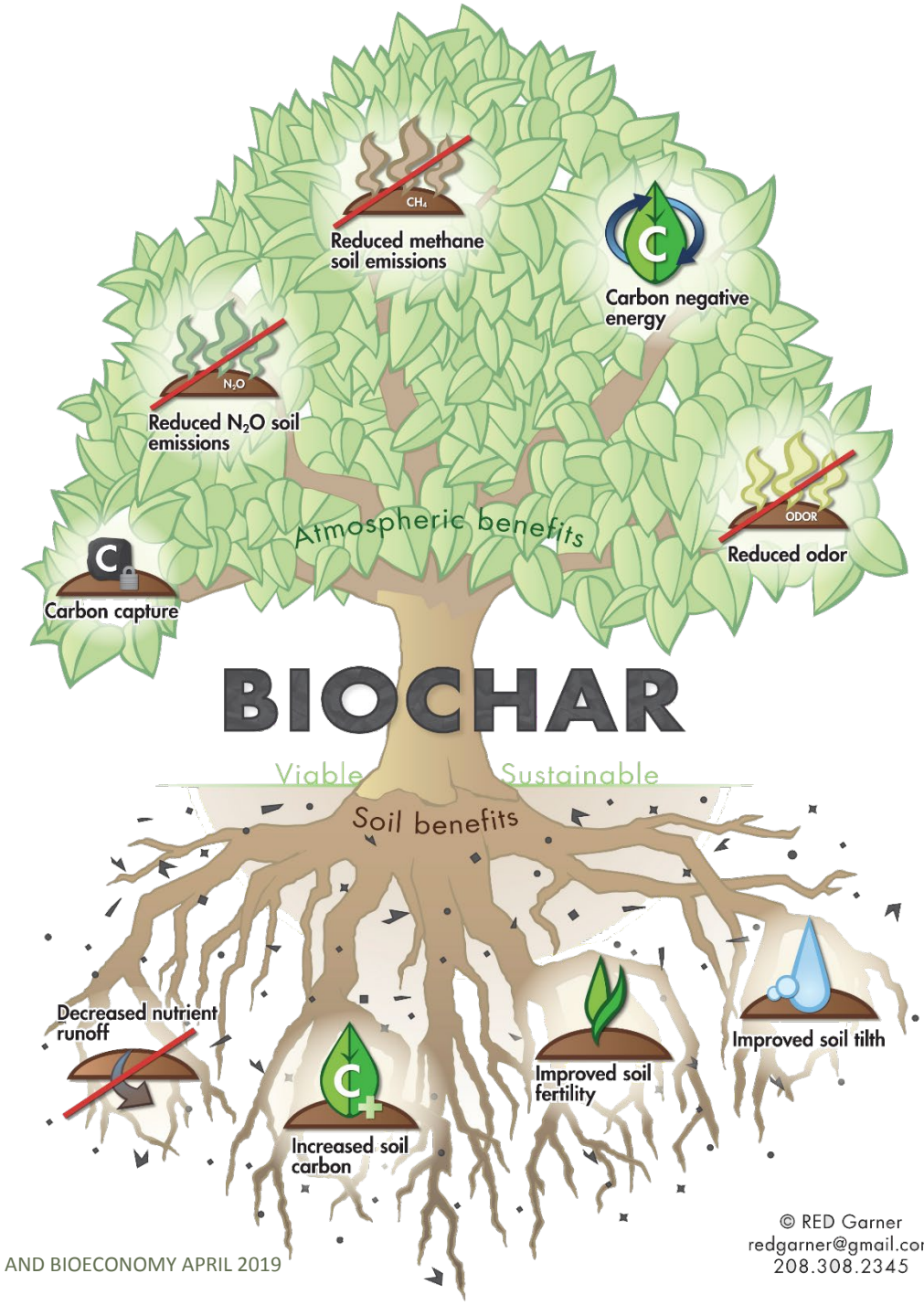
A little about me…

USDA Forest Service
Rocky Mountain
Research Station

- Soil productivity
- Harvesting
- Fire
- Sustainability
- Decomposition
- Soil monitoring



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Collaborators

Biochar spreader for forest sites

National Nursery Specialist

University of Idaho, Michigan Technological University, University of Montana, Humboldt State University, Washington State University

National Forests – Umpqua, Umatilla, Bitterroot, Idaho Panhandle, Beaverhead-Deerlodge, Humboldt-Toiyabe, Caribou Targhee

Forest Products Lab

Agricultural Research Station (Kimberly, ID; Florence, SC)

Curlew National Grasslands

Bureau of Land Management

Cool Planet, Phoenix Energy

This talk will cover….

- Why is soil so important?
- What can go wrong with land applications?
- What's right?
- Tree growth, forest nurseries, and biochar

Removing a source of soil C

To fix the climate, fix the soil!

Decades of soil overuse

- Intensive agriculture
- Deforestation
- Excess trafficking
- Invasive species

The Soil Fix!

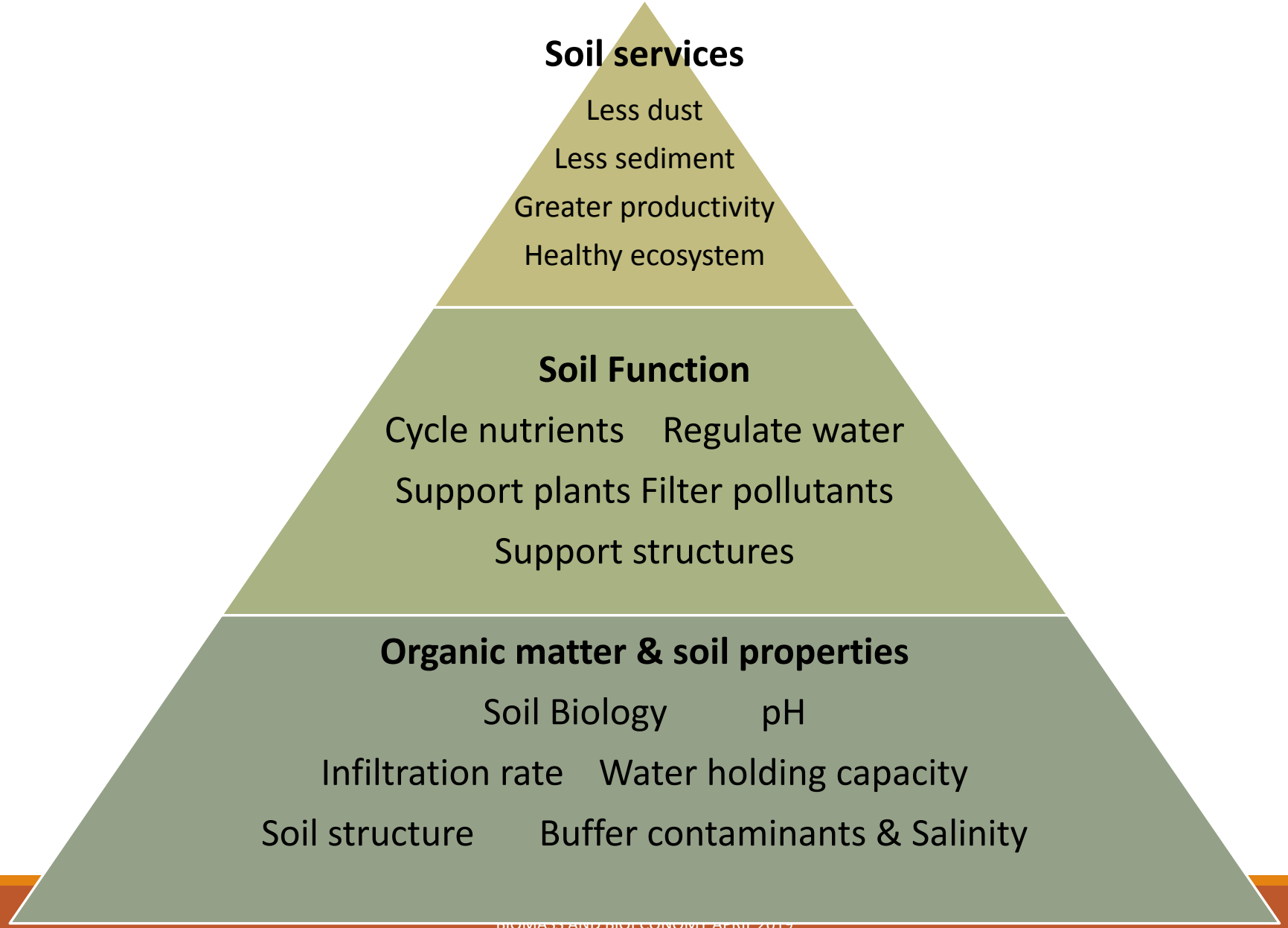
- HEALTHY SOIL: most effective natural system for C sequestration
- Soils store about 3,000 billion metric tons of C
  - Double the amount stored in vegetation and the atmosphere combined


DUST STORM APPROACHING SPEARMAN, TEXAS.
APRIL 14, 1935

Soil considerations or… fun soil organic matter facts!

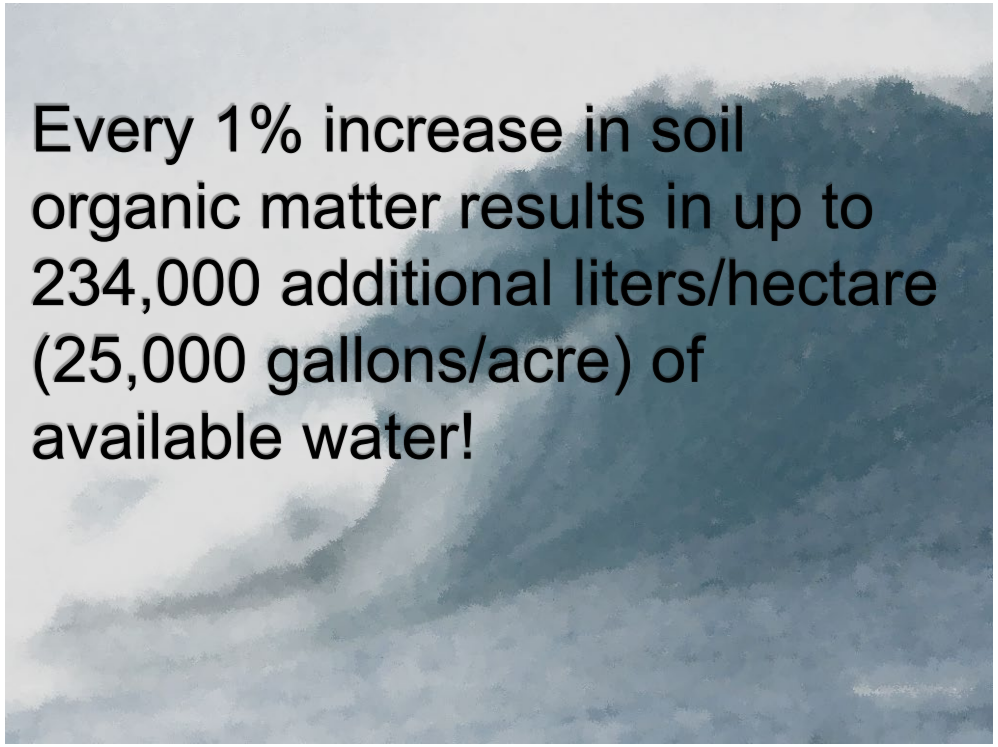
- Mineral Soil is ~5% organic matter
- More than 50% of soil OM has been lost from various ecosystems around the globe
- Loss of OM leads to reduced CEC, water retention, nutrient supply/retention
- Loss of OM is correlated with nutrient depletion – especially in tropical soils
- Overall reduced productivity with OM loss

Organic matter is the foundation of soil and ecosystem restoration



Soil resiliency: It's all about organic matter

- Response to OM additions varies by soil texture
- Biochar contributes a recalcitrant form of carbon
- Other organic amendments contribute labile organic matter
- Both types can increase water (nutrient) holding capacity



Biochar in forest ecosystems

- Char is common in fire-adapted ecosystems
- Fire suppression decreased charcoal inputs
- Charcoal holds nutrients and water for microbes
- Biomass removal (restoration thinnings) decreases the likelihood of fire occurring
- Applying biochar as a co-product of pyrolysis removes wildfire hazard *and* retains or restores soil ecosystem function

What could go wrong?

- Sorption of limited available nutrients
- Dilution of limited native nutrients
- Pyrolysis oils contaminate sites
- Not all biochar is equal (or useful)
  - Wrong pH
- Naturally hydrophobic

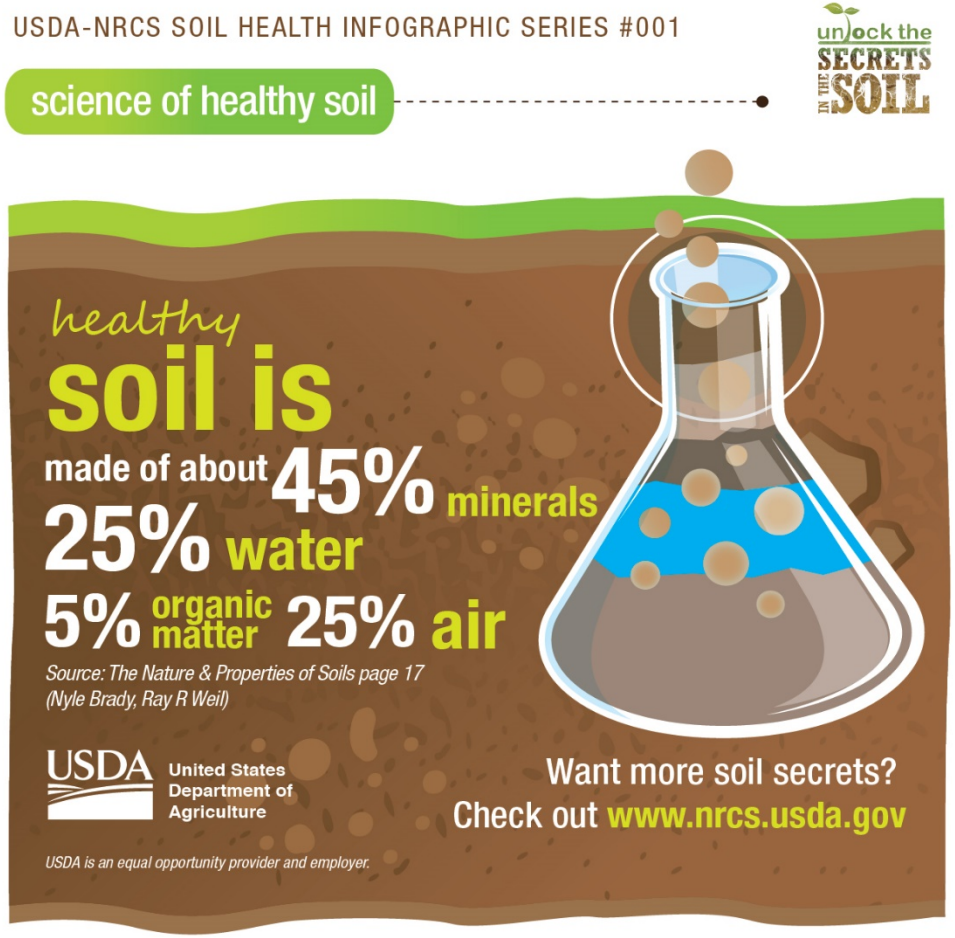
What could go wrong? Feedstock differences

Source of raw material	Biochar pH	Biochar electric conductivity (µs/cm)
Fire salvage (Umpqua National Forest)	8.1	103
Fire salvage (Bitterroot National Forest)	7.5	136
Cedar	8.7	364
Madrone	4.9	789
Mixed conifer slash pile	8.1	91
Oak	7.9	181
Scotch broom	7.5	234
Hog fuel	7.4	319

On the positive side:

Biochar can…

- Sequester Carbon
  - Wood: C content of ~ 50%. Biochar: C content of ~70-80%
  - Mostly permanently sequester C (some say 1000's of yr others say 100's),
  - wood releases CO_2 as it decomposes
- Biochar may reduce N fertilization requirements
- Reduce methane production and other GHG's
- Improve water holding capacity
- Increase symbiotic N-fixation

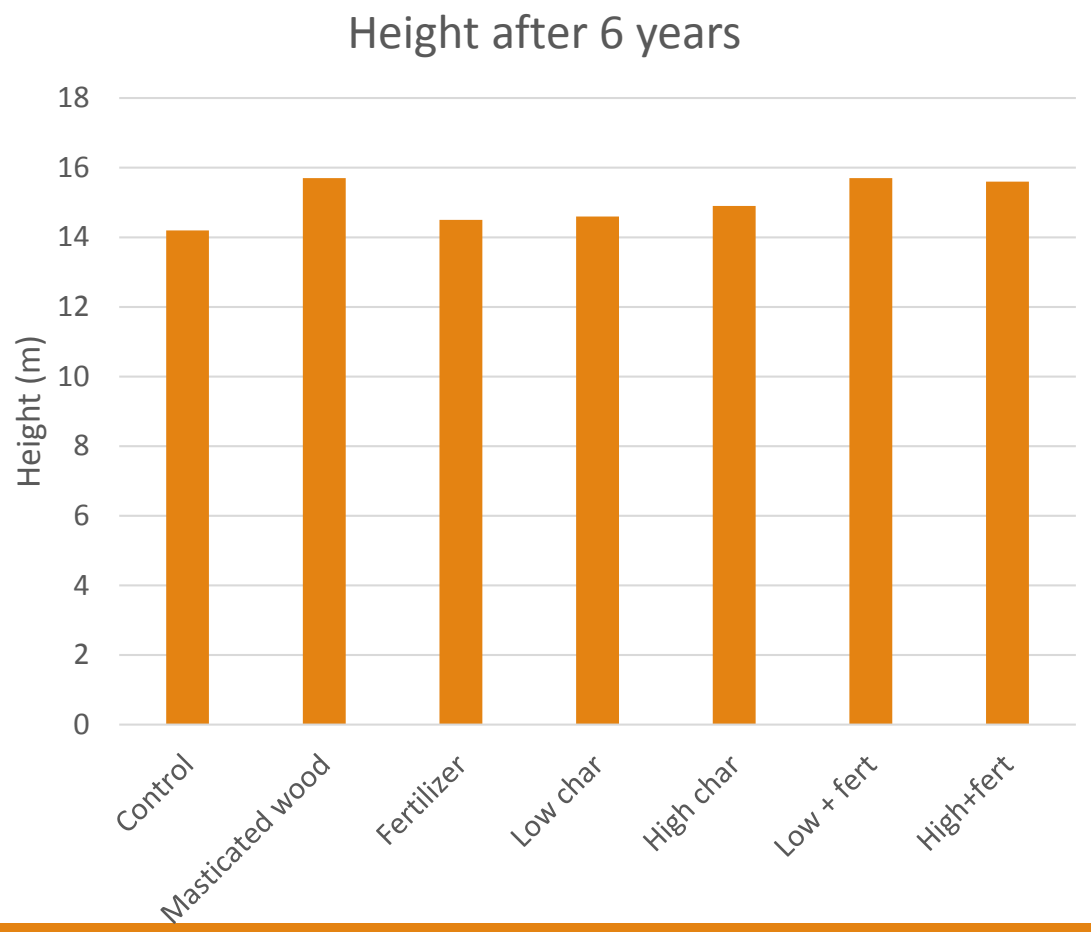


Opportunities to use biochar in forestry, range or mine soils?

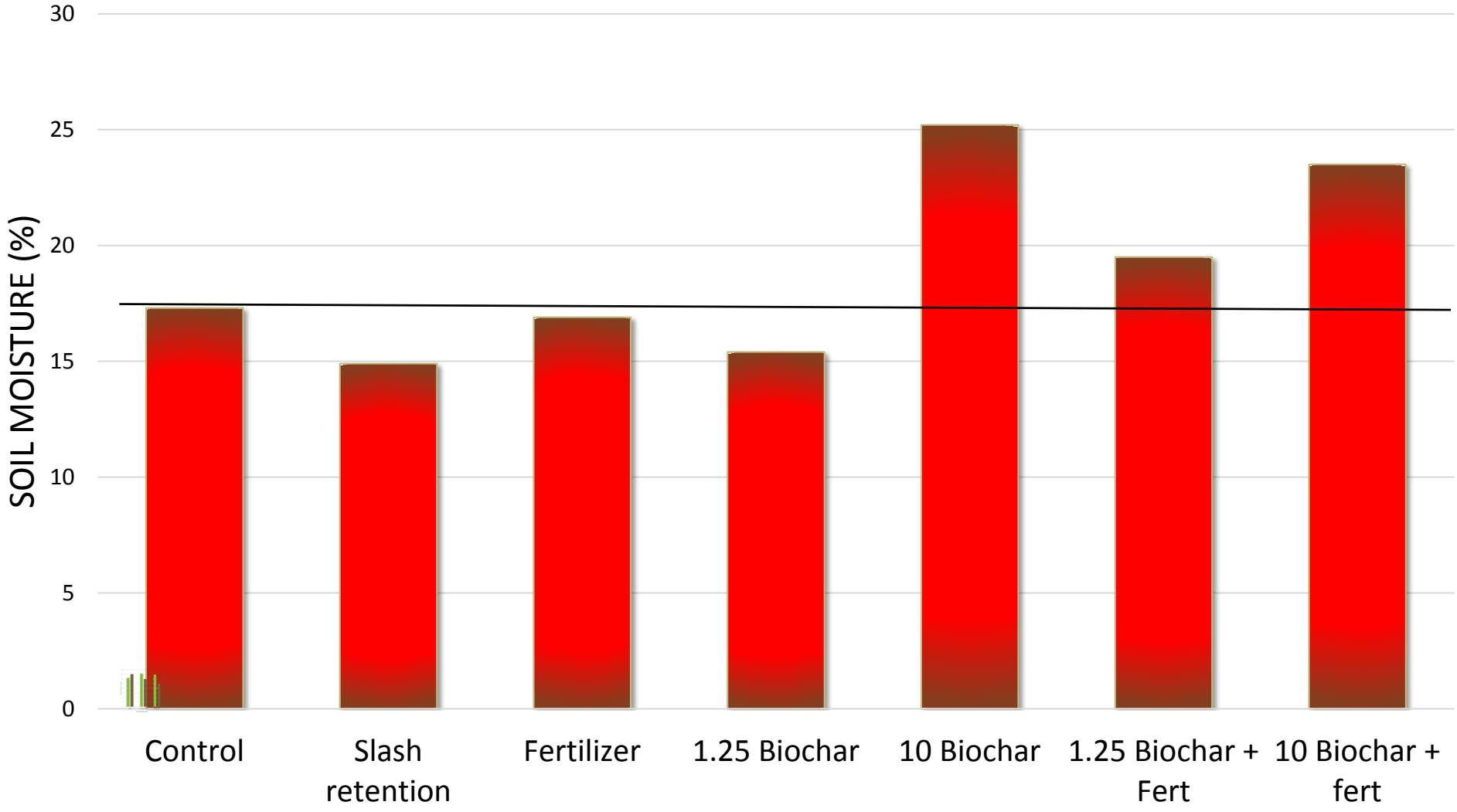
Forest tree response to biochar

Thinned stands (big trees)

- 4 replicates
- 7 treatments
  - Masticated wood, fertilizer, 2 levels of biochar (with and without biochar), control
- No significant differences



Change in soil moisture– Bitterroot National Forest



Not big trees

Small native plants/trees: Biochar added to nursery media

- Biochar can be added to or replace peat
- Biochar used to enhance nursery media properties
  - Adjust fertilizers
  - Reduce leaching
- Sequester C during outplanting
- Enhance seedling growth (boreal forests)
- Increase ectomycorrhizae
- Up to 25% biochar in plugs

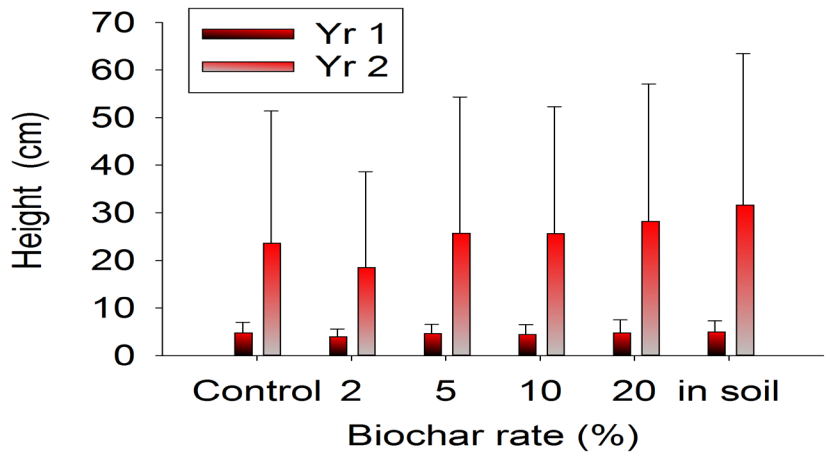
Nursery soils and biochar


Planting biochar-amended trees in Alabama

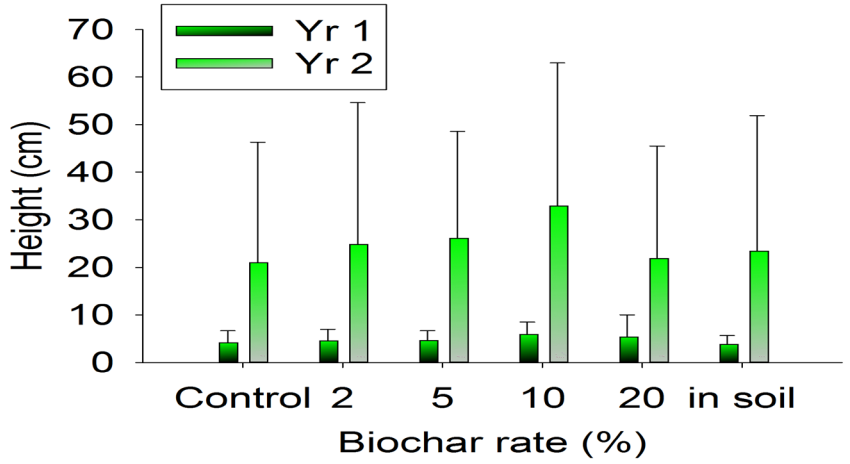
- Two species (long leaf and shortleaf pines)
- 4 replicates
- 6 treatments
  - 0, 2, 5, 10, and 20% biochar plus 1 in-soil treatment
- 15 seedlings/treatment

Longleaf seedling response to biochar

Cool Planet biochar



Mixed conifer biochar



Mine land restoration opportunities

- Approximately 160,000 abandoned mine sites in the western US
- Build OM using a mix of available products: biochar, wood chips, and biosolids
- Restoration of gas and oil pads (1.7 million wells in the U.S.)
- Capture toxic chemicals (mercury, lead, etc.)

Rangeland restoration opportunities

- Restoration of rangelands for increased forage
- Use piñon-juniper to create biochar
- Combine seeding with planting local species
- Extend plant growing season (lessen drought)
- Sequester C

Specialty markets

- **Food products (non-activated or activated charcoal)**
  - Drinks (Black Sand cocktails)
  - Pills to aid digestion
- **Beauty products (activated charcoal)**
  - Face masks
  - Cleansing gels
  - Shampoos
  - Soaps
  - Tooth paste

Summary

- Soil organic matter is important for healthy forests and range sites
- Biochar can increase soil organic matter and increase ecosystem services
- Soils matter (can you dig it?) – to fix the climate we must fix the soil
- Tree responses are small but other ecosystem services increase

Thank you

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