High severity wildfires have significant, lasting impacts on soils and forest watersheds. Nutrient and soil organic matter losses and physical changes that influence plant water availability can impede revegetation. Land managers commonly employ Burned Area Emergency Response (BAER) treatments to counter immediate post-fire soil loss, though these practices may also assist recovery of soil productivity and speed revegetation.

**Church’s Park Fire** a 200-hectare area burned in October 2010, is located in the Arapaho National Forest near Fraser Colorado (2438-3200 m elevation). The area receives ~700 mm of precipitation annually, 75% as snow. Forest vegetation consists primarily of mountain pine bark beetle-killed lodgepole pine (Pinus contorta) and aspen (Populus tremuloides). The burn sits on gravelly, sandy-loam Alfisols derived from colluvium and alluvium of granitic gneiss and schist parent material.

Conifer colonization was scarce the first 2 yrs after the fire owing to combustion of cones on beetle-killed pines. Tree regeneration is limited to aspen sprouts.

**Study Overview**

We investigated the potential of pine biochar to contribute to reclamation of areas affected by high severity wildfire and subsequent erosion on skeletal soils in the Colorado Rockies. We compared biochar rates (0, 2, and 20 t ha⁻¹) and wood mulch addition in a replicated field study and complementary greenhouse trial.

**Field Study**

Biochar had no effect on soil temperature (5 cm depth) in 6 study blocks, but char applied alone and in combination with wood chip mulch both consistently increased volumetric soil moisture compared to untreated soil (p < 0.01).

**Greenhouse Soil and Tree Bioassay**

Addition of 20 t ha⁻¹ of biochar significantly reduced 1 M KCl extractable soil ammonium and increased soil nitrate during most of the 6 month greenhouse assay. In contrast, the lower char addition had few effect on the inorganic soil N forms.

**Soil Cations and P**

Biochar increased tree seedling growth under the dry watering regime, but had no effect under wet conditions. In the dry watering regime the 20 t ha⁻¹ char addition created soil moisture equivalent to the wetter regime. However, char did not elevate soil moisture further when applied under the wetter regime.

**Biochar**

*Feedstock:* Blue-stained, lodgepole pine chips 8-10% moisture content

*Pyrolysis:* Biochar Engineering Corporation (BEC)

  - Step 1 O₂-limited, 700-750 °C, < 1 minute
  - Step 2 O₂-free, 400-550 °C, 10-15 minutes

*Biochar Composition:

<table>
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<tr>
<th>Component</th>
<th>Moisture</th>
<th>pH</th>
<th>Surface Area</th>
<th>Total Pore Vol.</th>
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<tbody>
<tr>
<td>Ash</td>
<td>9.4</td>
<td>9.4</td>
<td>87.2</td>
<td>0.105</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>N</td>
<td>0.4</td>
<td></td>
<td>176</td>
<td></td>
</tr>
<tr>
<td>O</td>
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</table>

Characterization - D.W. Rutherford et al., USGS, Lakewood, CO

**Biochar Leachate**

*Change in standard solution (l/L*):*

<table>
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<th>Component</th>
<th>DOC</th>
<th>TKN</th>
<th>NH₄-N</th>
<th>NO₃-N</th>
<th>PO₄-P</th>
<th>Ca</th>
<th>K</th>
<th>Mg</th>
<th>SDC</th>
<th>RDC</th>
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<tbody>
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<td>0.3</td>
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<td>1.9</td>
<td>1.9</td>
<td>1.9</td>
<td>3.2</td>
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<tr>
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<td>0.3</td>
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<td>1.9</td>
<td>1.9</td>
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<td>3.2</td>
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</table>

*Key Findings & Potential Utility**

**Soil Moisture** Blue-stain biochar added at 20 t ha⁻¹ influenced soil moisture across a range of field moisture and conditions. This rate of biochar also increased soil moisture and seedling growth in dry greenhouse soils. Under wet conditions, biochar did not result in higher soil moisture or tree growth.

**Soil Nutrients** Blue-stain biochar both releases and retains soil nutrients and alters soil chemistry. The char added an equivalent of 5-10 kg Nitrate-N ha⁻¹ to the 24 week greenhouse assay. It also adsorbed ~1 kg N ha⁻¹ of ammonium.

**Potential Utility** These findings suggest that blue-stain biochar may assist with tree growth on xeric soils altered by high-severity wildfire. Additional work is needed to determine if biochar provides an effective approach to general revegetation of burned and otherwise disturbed ecosystems.