

## Burn Severity Lab Experiment (BSLE) Burning Protocol

Pacific Northwest National Laboratory River Corridor Science Focus Area – Research Campaign 3

### Summary of Vegetation Treatments:

Four species treatments with 7 treatments total:

- **Target ratio of canopy:** woody was approximately 40%-60% based on dried plant mass. Canopy is equivalent to needles & twigs <0.5cm in diameter.
  - **Target Amount:** at least two 30 gallon lawn bags (one filled with living vegetation and one filled with dead vegetation) per plant species.
  - **Target Material:** Needles/leaves, twigs, branches sorted into dead and living for each species. See Vegetation Collection protocol for vegetation collection details.
1. Douglas fir Forest (x2 - 1 with living plant material, 1 with dead plant material)
    - a. Plant species = Douglas-fir (*Pseudotsuga menziesii*)
    - b. Representative land category: [East Cascades Mesic Grand Fir - Douglas-fir Forest](#)
    - c. Ratio (by mass): 100% Douglas-fir (40% canopy, 60% woody)
  2. Mixed Conifer Forest (x2 - 1 with living plant material, 1 with dead plant material)
    - a. Plant species = Douglas-fir (*Pseudotsuga menziesii*) + Ponderosa Pine (*Pinus ponderosa*)
    - b. Representative land category: [Central Rocky Mountain Douglas-fir - Pine Forest](#)
    - c. Ratio (by mass): 50% Douglas-fir, 50% ponderosa of total mass, (within each species 40% canopy and 60% woody)
  3. Sagebrush Shrubland (x1 - 1 with combined living & dead plant material)
    - a. Plant Species = Big sagebrush (*Artemisia tridentata*)
    - b. Representative land category: [Intermountain Dry Tall Sagebrush Shrubland](#)
    - c. Ratio (by % mass) = 100% sagebrush
  4. Mountain Woodland (x2 - 1 with living pine material, 1 with dead pine material)
    - a. Plant Species = Big sagebrush (*Artemisia tridentata*) + Ponderosa Pine (*Pinus ponderosa*)
    - b. Representative land category: [Central Rocky Mountain Ponderosa Pine Woodland & Savanna](#)
    - c. Ratio (by mass): 50% sagebrush, 50% pine (which is 40% canopy, 60% woody)

### For Muffle Furnace Treatments:

Building land cover treatments (for muffle only):

1. Air dried vegetation needs to be homogenized and then sorted into appropriate ratios for each of the 7 vegetation treatments with a total target fuel mass of **~300g of biomass**. Reserve some air-dried vegetation for control, unburned samples.
2. Record exact weights in a lab notebook of each plant species & biomass categories before combining in paper bags. Then record exact total mass weight (should be close to 300g for each treatment).
3. After sorting into burn categories, store dried material in a controlled room until time of burn.

#### Experimentally Added Moisture:

1. Select the bags of dried feedstock material which are labeled for moist burn conditions.
2. 12-24 hours before burn: Record total weight of material in paper bag
3. Place material into a clean, pre-combusted glass pyrex container (be sure tare weight of pyrex container is recorded).
4. With a clean misting spray bottle, full of 18.2 Milli-Q water, lightly wet the entire surface of the vegetation with Milli-Q water. (ref: [Westerhof et al. 2007](#), See also [de Diego et al 2002](#)). Apply between 30-40mL of water to the vegetation material. Record how much water was used.
5. Toss vegetation in water and then immediately drain.
6. Re-weight the wetted material.
7. Cover pyrex containers with pre-combusted foil. Let sit overnight up until time of burn.
8. Estimate moisture content in % =  $[\text{wet weight} - \text{dry weight}] / [\text{dry weight}] * 100$ .

#### Muffle Furnace Burns

1. Place all biomass from a single vegetation class into a clean [rectangular crucible](#).
2. Photograph pre-burn material assembled in the crucible.
3. Record pre-burn mass of vegetation
4. Set furnace settings for a max temp of 250°C for 1h with a ramp up speed set to 30°C/min.
5. After burn time, crack the furnace door with fan until it reaches approximately 80°C. Remove crucible with heatproof gloves and let cool until room temperature.
6. Once cool, photograph and then record char weight.
7. Pour char in appropriately labeled paper bag and store until laboratory analysis.

### **For Open-Air Burn Table Treatments:**

#### Pre-burn table preparation

1. Clip all vegetation to lengths less than 2.5ft (to ensure they will fit into burn table squares).
2. Remove ~125g of each species and place into a separately labeled bag and reserve for unburnt control samples.
3. Record total air dried vegetation weights for each species.
4. Secure all vegetation (by species) in lawn bags for safe transport

Once at Oregon State University:

1. Weigh out vegetation into individual veg & burn treatments based on target ratios. Label each pre-tared bag to associate with each burn treatment (*ex: Douglas Fir Forest living dry for Burn01a* )
2. Record total weight of each plant species and total weight of vegetation treatment.
3. For mixed treatments, shake and mix material in its lawn bag to ensure thorough homogenization of plant species.

Experimental Moisture Manipulation:

1. Place pre-weighed vegetation treatment into a clean, tared, 6 gal aluminum bucket. Record the weight.
2. Add Milli-Q for a total of 1 g H<sub>2</sub>O per g of plant material.
3. Secure on the lid and then roll the bucket around to evenly coat plant material. Immediately drain any standing water.
4. Weigh the wet plant material
5. Cover plant material and let sit overnight until burn.
6. Repeat with each plant treatment necessary. Be sure to clean/wipe out the bucket with IPA/MeOH before reusing.

At burn table prep:

1. Place vegetation treatments for the specific burn treatment into the correctly associated square on the burn table. Photograph each individual square. Burn table is tilted at approximately 30° angle.
2. With a ruler measure depth of vegetation at center and for corners of each square. Record depth. Will be used to calculate fuel density on the burn table.
3. Dry treatments are placed in the center square and wet treatments are placed in the top square.
4. Record orientation on burn table in data sheet templates as well as thermocouple #'s and location on "master diagram of burn table" sheet.
5. Connect thermocouples to datalogger.
6. Place a pile of "starter" straw material in the bottom square.

During burn:

1. Ignite a match and start burning the straw pile. Record time. Start video recording.
2. Once flame height on straw becomes significant, lift the metal barrier between the straw and the center square a few inches; allow flame to catch on dry vegetation treatment. Record time when flame catches.
3. Track temperature, when thermocouples reach 300°C, use cleaned stainless steel tongs to scoop up a grab sample of char. Place char into aluminum bucket, snuff immediately with lid. Repeat process at 600°C.
4. When flames reach the top of the center square, lift metal barrier between the center and top square. Allow flames to catch onto wet vegetation treatment. Record flame start time.
5. Repeat 300°C and 600°C grab samples in the top square.
6. Record time when flaming and smoldering stops.
7. Video record each burn on go-pro
8. Take notes.

#### After burn:

1. Once cool enough to approach, photograph each individual square on the burn table (be sure a label of which treatment it is is visible) & record photo #. This will be used later for burn severity analysis. Photograph each char grab sample as well.
2. Use a clean stainless shovel with gloves on and visually assess if any of the remaining ash on the burn table qualifies as “complete combustion” (following visual methods described in [Parsons et al. 2010](#)). Subset complete combustion sample if present, photograph and collect in pre-weighed jar.
3. Homogenize remaining char and collect in a paper bag labeled appropriately.
4. Record weights of collected char & ash. Photograph all solid samples collected.
5. Clean burn table in preparation for next run.
  - a. Wipe down the metal barrier thoroughly with IPA and/or methanol. Let dry COMPLETELY before starting the next burn. Relabel with appropriate vegetation + burn treatments.
6. Repeat all above steps for each of the 8 burns.
7. Be sure chars are stored in a climate controlled, well-ventilated room until time of laboratory analysis.

#### Burn Severity Assessments:

1. Gather all photographs of solid char samples
2. Visually assess each photo and assign it a burn severity category (low, moderate, or high)

3. Base vegetation burn severity on descriptions outlined in [USFS Parsons et al. 2010](#) field guide. Burn severity was visually determined based on ash color, degree of consumption, and degree of char on vegetation.
4. Record assigned burn severities.