Forest Service
U.S. DEPARTMENT OF AGRICULTURE

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Slash pile fate: Decomposition, burning, or biochar?

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A few key collaborators

Nate Anderson – supply chain

Kas Dumroese – growing seedlings

Derek Pierson – carbon

Dan McCollum – economics

Carlos Rodriguez-Franco – forest management

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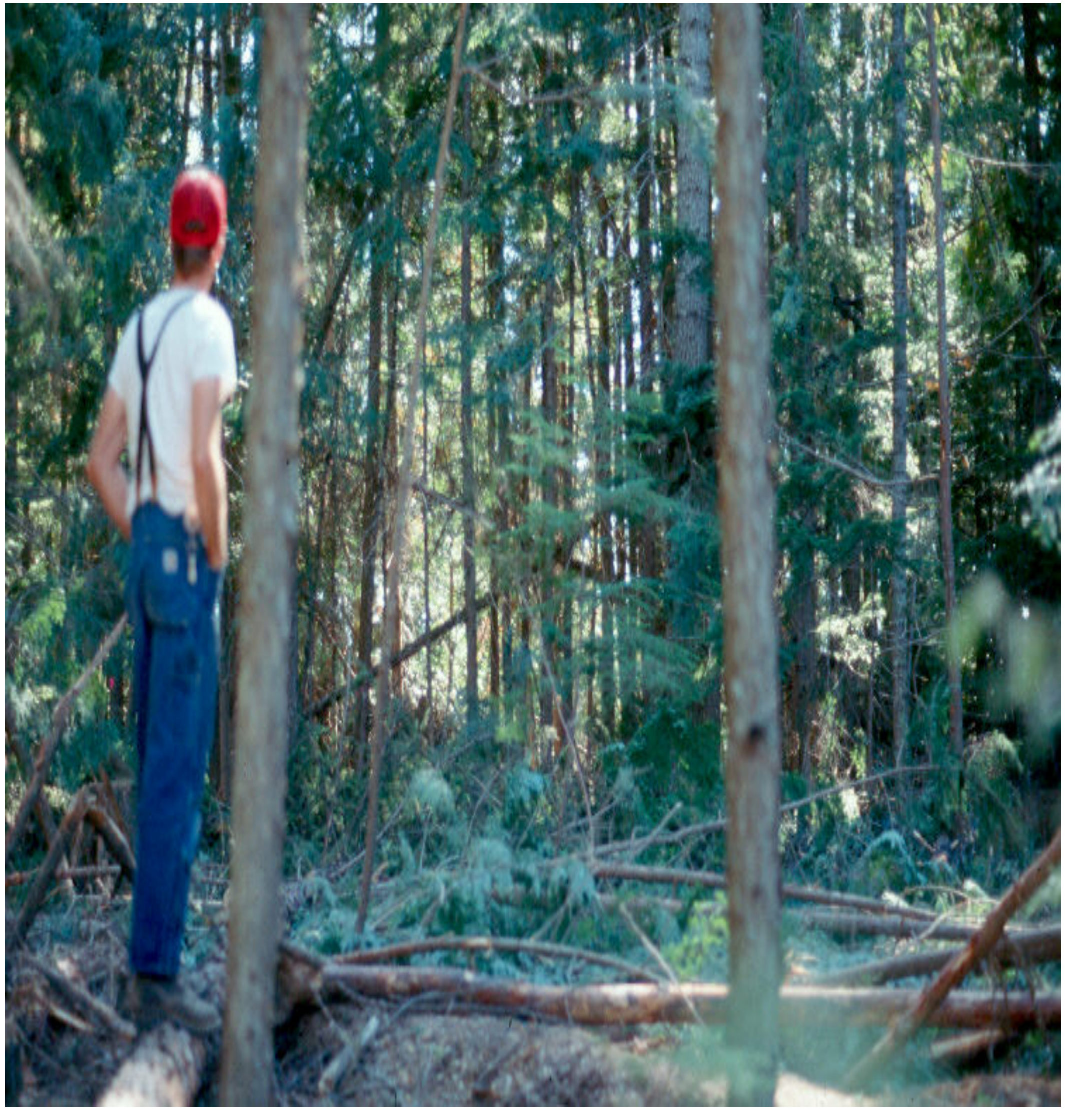
Overview

- Why are piles made?
- Dispersed coarse wood
- Soil impacts of pile burning
- Decaying piles
- Slash piles and biochar

Too much low-value woody biomass!



- Overstocked forests
- Long-term droughts
- Fire suppression
- Insects and disease
- Dead trees
- Lack of infrastructure
- No or few markets for small-diameter material

Choices and finding balance

Challenges in land management, social science, and climate change

What to do with unmerchentable wood?

- Leave some coarse wood
- Burn
- Decompose
- Biochar
- Combinations?

Leaving wood behind

"To keep every cog and wheel is the first rule of intelligent tinkering" – Aldo Leopold (1953)

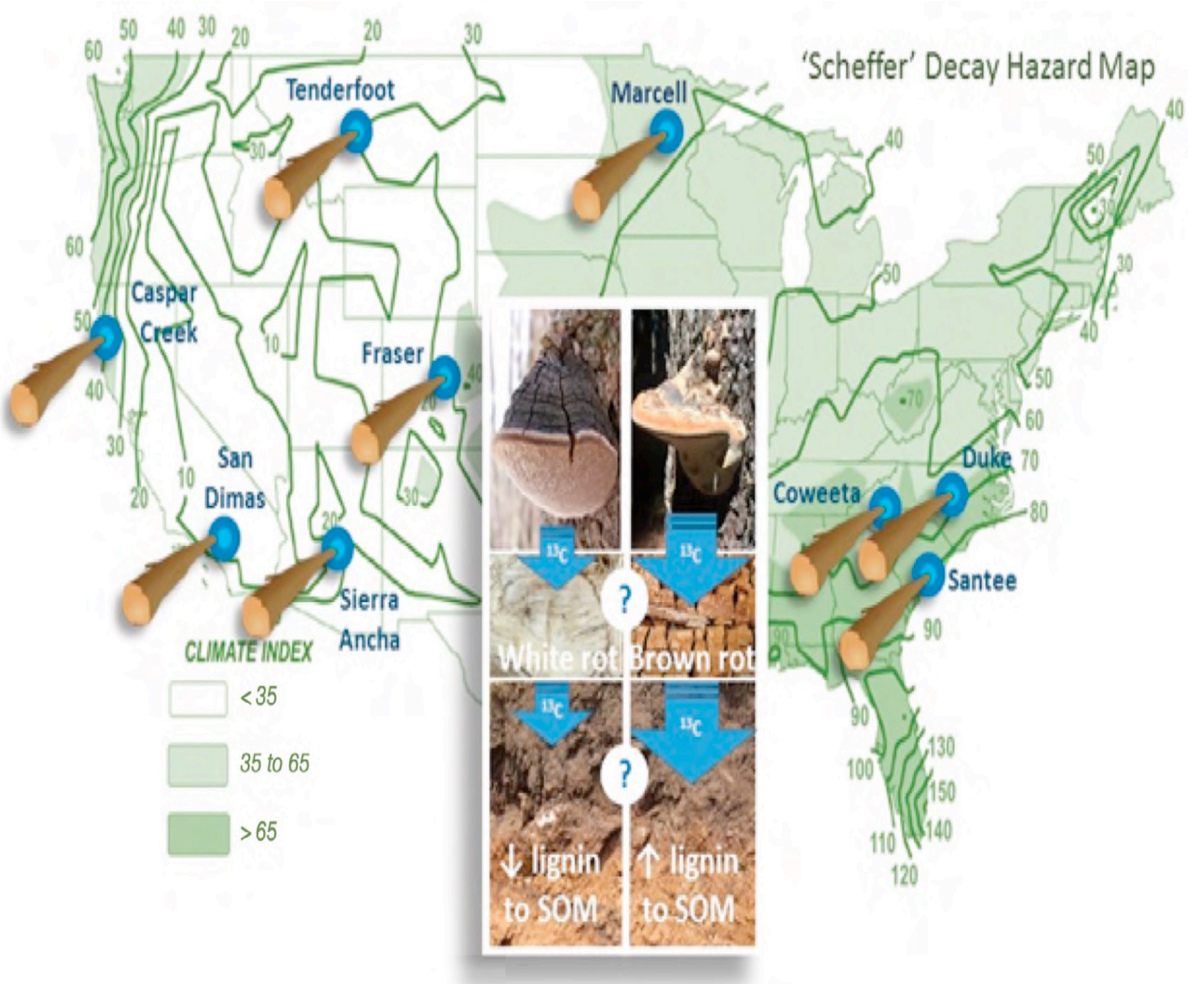
Dead (standing and downed) are the cogs and wheels.

- Provide a range of ecosystem services:
  - Wildlife habitat (vertebrate and invertebrates)
  - Moisture storage
  - Fungal refugia
  - Non-symbiotic nitrogen fixation

- Large wood (>7 cm diameter) is generally not a wildfire risk
- Leave 10-74 Mg/ha, depending on forest type
- Does coarse wood add to soil C pools?

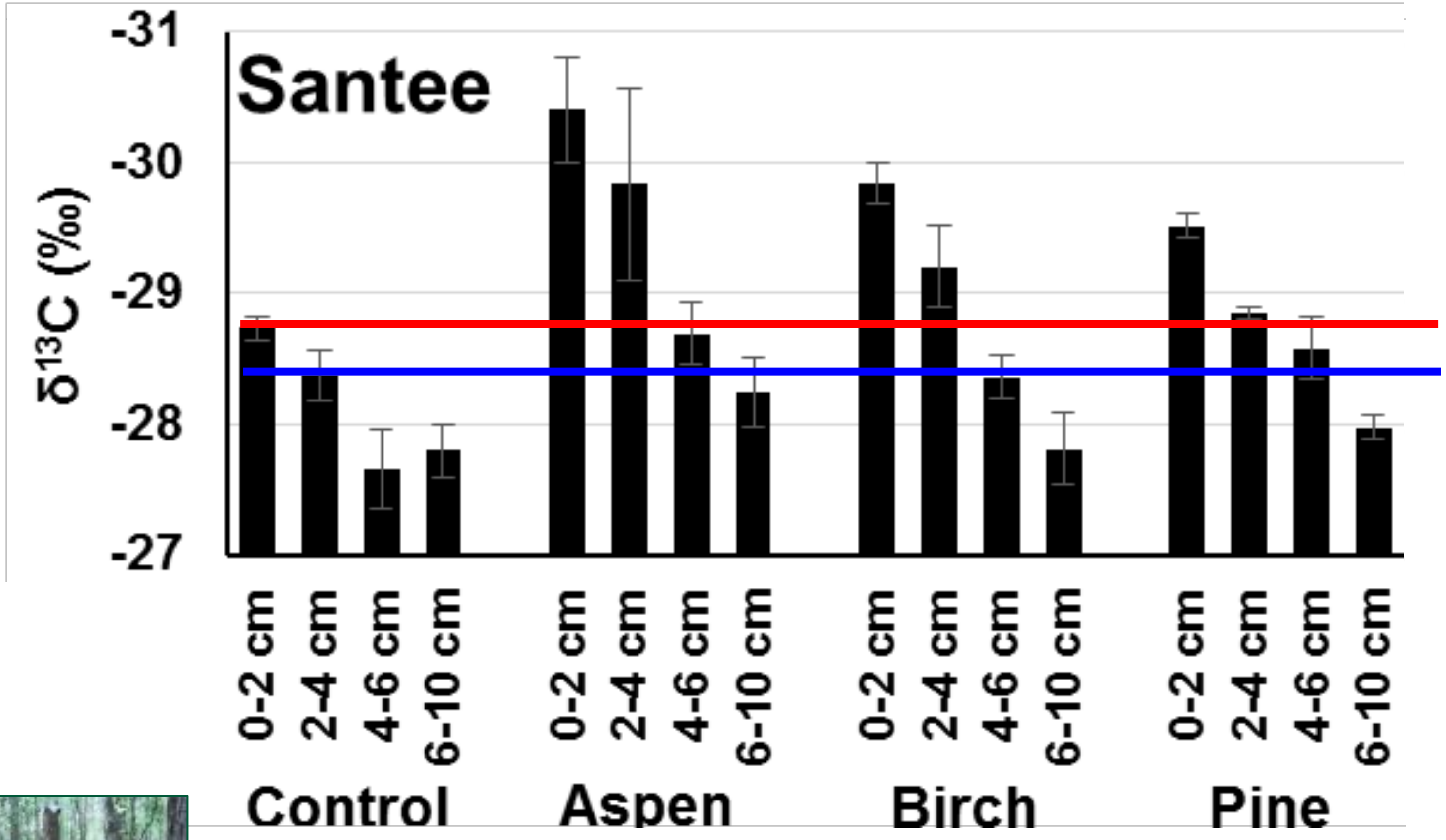
From: R.F. Powers, A.E. Tiarks, J.R. Boyle 1998.Assessing soil quality: practicable standards for sustainable forest productivity in the United States.M.B. Adams, K. Ramakrishna, E.A. Davidson (Eds.), The Contribution of Soil Science to the Development of and Implementation of Criteria and Indicators of Sustainable Forest Management. SSSA Special Publication no. 53, Soil Science Society of America, Madison pp. 53-80

Carbon sequestration from coarse wood → decomposition



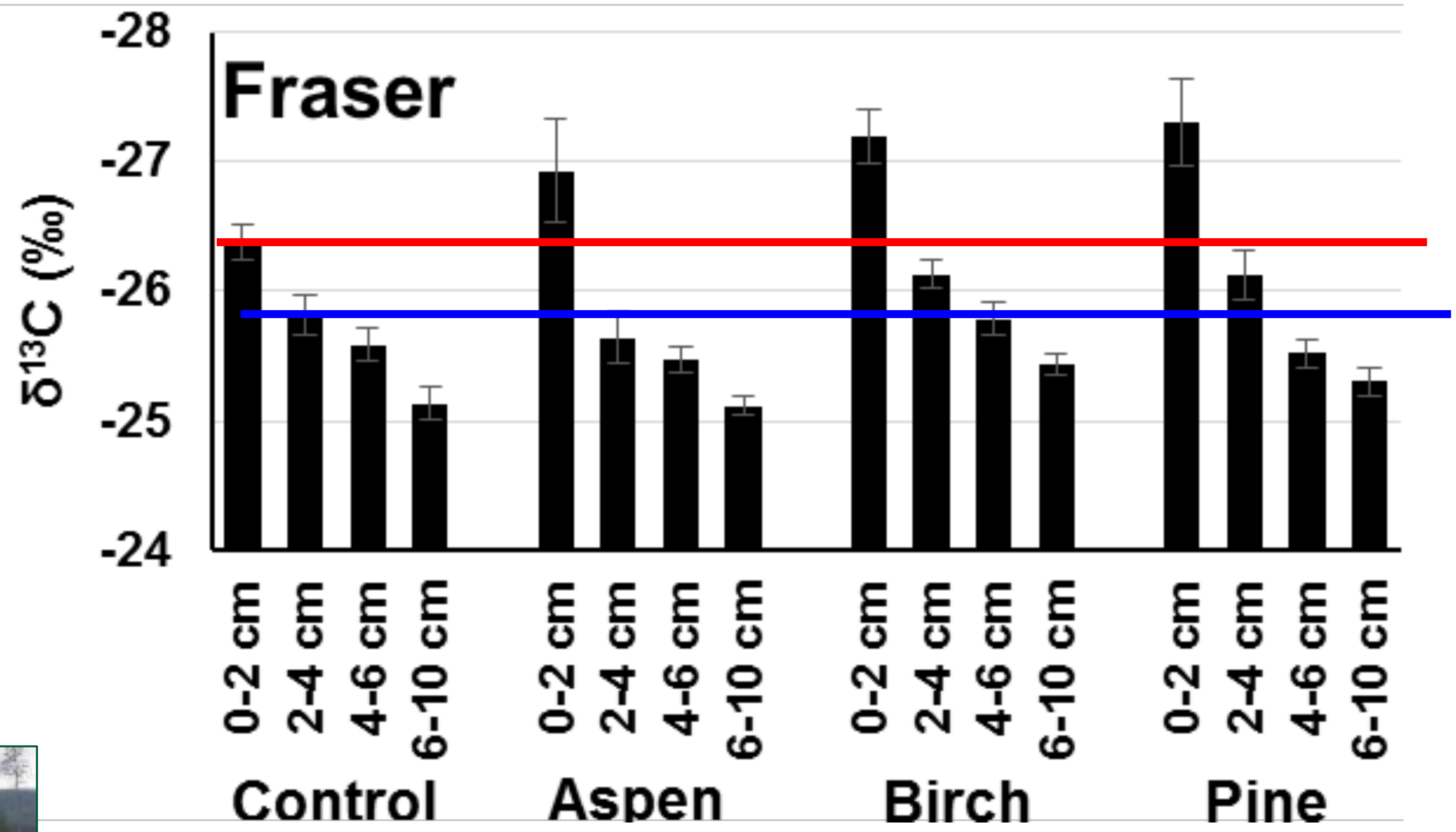
From: Trettin, Carl C.; Burton, Andrew; Jurgensen, Martin F.; Page-Dumroese, Deborah S.; Dai, Zhaohua; Oren, Ram; Forschler, Brian; Schilling, Jonathan; Lindner, Daniel. 2021. Wood decomposition and its role in the forest carbon cycle: the FACE wood decomposition experiment. Gen. Tech. Rep. SRS-262. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 33 p. https://doi.org/10.2737/SRS-GTR-262.

Incorporation of Wood C into the Mineral Soil – Southeastern Coastal Plain (warm, moist)



MAP = 1335 mm
MAT = 17.2 °C

Incorporation of Wood C into the Mineral Soil – Rocky Mountains (cold, dry)



MAP = 596 mm
MAT = 2.7 °C

Coarse wood and C pools

- The variable decomposition response was expected;
- **Determined that coarse wood does contribute to the soil C pool**
- Land management should include leaving standing and downed coarse wood to improve soil C pools
  - Not all coarse wood has to be piled

Slash piles

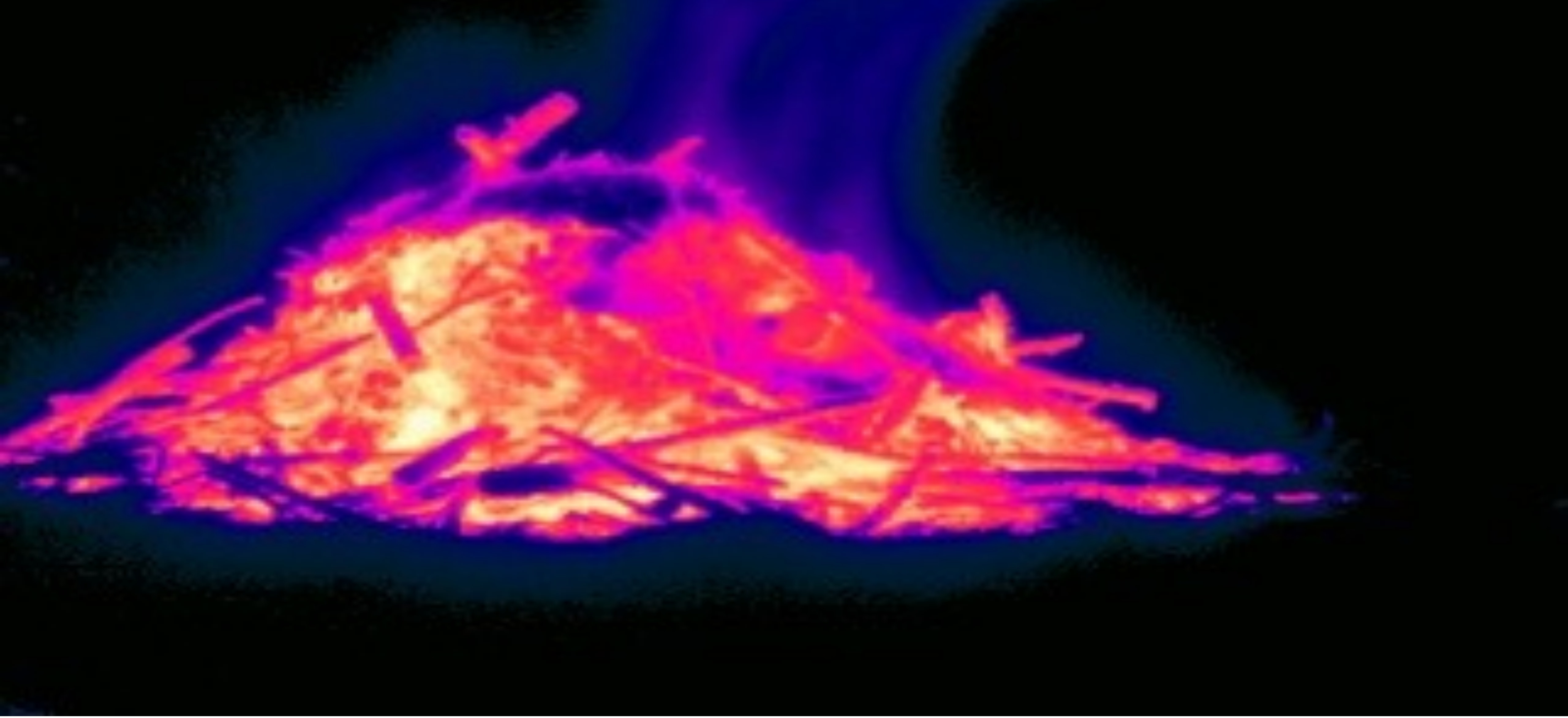
Pile building considerations

- Fuel type and size
  - Branches v. boles
- Fuel moisture
  - Dry fuels smolder less
- Pile quality
  - Avoid soil within the pile
- Spacing
  - Piles with large material should occupy <15% of the area.
- Avoid repeated pile burning

Why land managers make slash piles

- **Fire exclusion and lack of harvesting**
  - Overstocked stands
- **Difficult to use broadcast burning**
  - Iterative harvests needed for safety
- **Harvesting, thinning, and salvage Logging created tons of slash**
- Piles are effective **for residue removal**
- **Can be inexpensive to burn**
- Burning can facility **seed-bed preparation** for new plantings

Burning to reduce pile volume



Burning slash piles

- **Fast, efficient** method to consume fuels
- Can have a lengthy smoldering time
- Use under a broad range of **climatic conditions**
- Options for **reducing smoke** to nearby populations

Emissions from slash pile burning

- Varies
  - Feestock
  - Size
  - Tree part (bole, twigs, needles, leaves)
  - Moisture content
  - Soil in the pile
- Most emissions occur when piles smolder
- Open burning produces CO, CO_2, NOx, CH_4, plus particulate matter

Pile disposal and soil impacts

- Soils are complex and non-renewable (in our lifetime)
- Harvest activities or fuels reduction can alter soil properties
  - Erosion
  - Compaction
  - Nutrient availability
  - Burn scars
- Fuels reduction is iterative
  - Repeated stand entries

"Small changes in soil properties… that might seem insignificant may become significant after repeated rotations of an acceptable practice" – Davis et al. 2010.

Davis, R.L.; Sanchez, F.; DeHart, S. 2010. Soil Quality Standards Monitoring Program administration and implementation. In: Page-Dumroese, D.; Neary, D.; Trettin, C., eds. Scientific background for soil monitoring on national forests and rangelands. Proceedings RMRS-P-59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 121–127.

Soil impacts under burn piles

- **Elevated burn temperatures** under concentrated fuels
  - Heat transfers to soil via conduction
  - 120-160oC is lethal temperature to most living organisms
  - Temperatures >500oC cause **irreversible** physical, chemical, biological, and hydrological changes

Soil impacts: Physical properties

- Altered particle size distribution and loss of aggregate stability
  - Slower infitration
- Loss of organic matter
  - Soil stability decreases
  - Soil erosion increases
- Altered thermal properties
  - Soil retains more heat up to 15 cm deep
- Coupled with chemical changes
  - Surface repellency
  - Erosion

Soil impacts: Chemical properties

- Short- or long-term change in pH
- Increased potassium, calcium, and magnesium
  – In excess of seedling requirements
  – Leaching
- Can increase or decrease N availability
- Phosphorus can be 4x greater after burning
  – Elevated for up to 6 years

Soil impacts: Biological properties

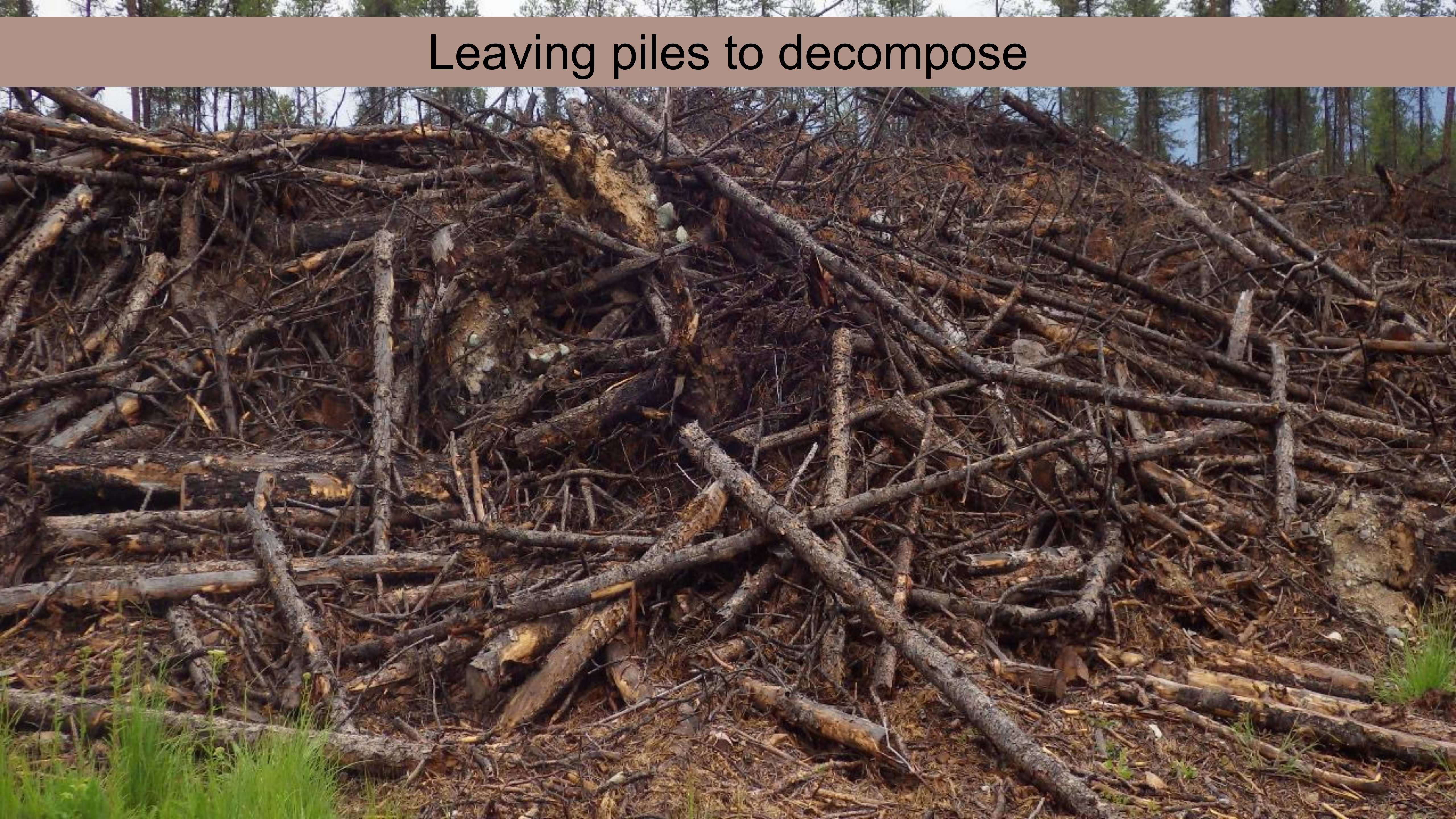
- Kills many microbes
- Changes microbial community structure
  - Short- and long-term effects
- Loss of ectomycorrhizal fungi
- Fire severity, duration, and magnitude

Carbon sequestration from pile burning

- Burning releases ~ 92-94% C into the atmosphere
- ~0.05 and 0.34 Mg C/ha converted to charcoal

From: Finkral et al. 2012. https://doi.org/10.1139/x2012-112

Leaving piles to decompose



Economics of leaving piles to decompose

– Most economical solution for piles
– Wildfire risk when dry
– Takes up valuable growing space

Emissions from pile decomposition

- Drivers of emission rates include
  - Temperature
  - Tree species
  - Fungal species (and richness)
  - Wood density
- Emit CO2 as wood decomposes
- Highly decomposed logs (Class 4 and 5) emit N_2O and CH_4

Carbon sequestration from pile → decomposition

- Can take 5-50 years
- ~2% increase in soil C under piles

From: Gonzalez-Benecke et al. 2010. https://doi.org/10.1016.j.foreco.2010.05.038

Place-based biochar production

Place-based biochar production

- Variety of methods
  - Kilns
  - Conservation burn piles
  - Air curtain burners
- Create durable carbon
- Remove wildfire risk near roads and landings

Economics of place-based biochar production

It depends:

- Method
- Slash location
- Harvest season

- Align workforce with slash production and biochar creation

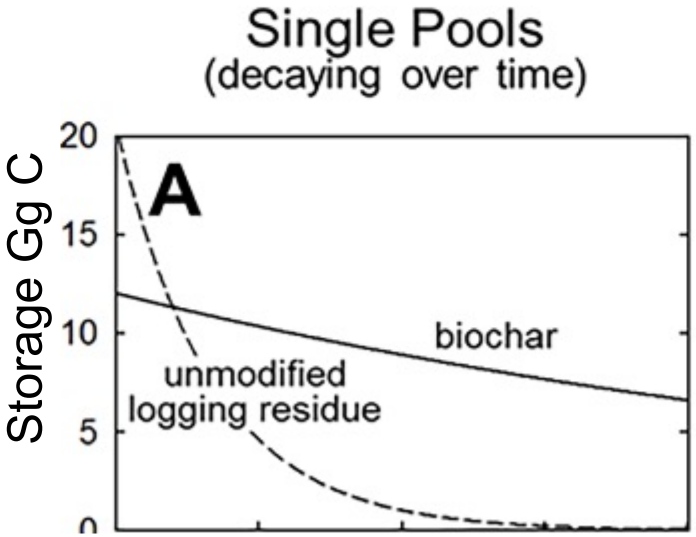
Soil impacts

- Little heat transferred to soil
- Ash
- **Biochar** for remediation!
- Reduce piles for additional growing space

Emissions

- Fewer emissions than open burning
  - Flame cap
  - Air curtain
  - Piles burned for biochar production

Carbon sequestration → applying biochar



From: Campbell, J.L., Sessions, J., Smith, D. and Trippe, K., 2018. Potential carbon storage in biochar made from logging residue: Basic principles and Southern Oregon case studies. *PloS one*, *13*(9), p.e0203475.

Finding common ground

Wood, carbon, and pile management

- Managing low-value biomass
  - Reduce wildfire risk
  - Improve soil and forest health
  - Reduce emissions
  - Sequester carbon
- Woody detritus management
  - Biodiversity, erosion control, seedbed, water/nutrient storage, habitat
- Policies and practices to promote place-based biochar production

Thank you for joining this panel!

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