USING FIRE TO INCREASE SOIL CARBON AND WATER HOLDING CAPACITY

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A BIT ABOUT ME



- Reduce slash pile burning
- Increase use of low-value woody biomass
- Make biochar
- Environmental consequences of adding biochar to forest, range, and mine sites around the west

BIOCHAR IS EQUIVALENT TO NATIVE CHARCOAL IN FOREST ECOSYSTEMS

- Char is common in fire-adapted ecosystems
- Fire suppression decreases charcoal inputs
- Biomass removal decreases the likelihood of fire occurring
- Applying biochar removes wildfire hazard and retains soil ecosystem function



BENEFITS OF CHARCOAL IN SOIL

- Lasts a long time in the mineral soil
- Stable carbon source
- Resists decay
- Increases water holding capacity



CHARCOAL BUILDS WATER HOLDING CAPACITY

USDA-NRCS SOIL HEALTH INFOGRAPHIC SERIES #002

what's underneath

 Most soils can benefit from added charcoal/organic matter

 1-30% conversion rate from green biomass to charcoal

BIOCHAR IN PUMICE SOIL: 20% INCREASE IN WATER HOLDING CAPACITY

FUEL CONSUMPTION AND CHARCOAL FORMATION (NOT THE SAME EVERYWHERE)

	Forest floor consumed	Coarse wood consumed	Charcoal produced
Ponderosa pine forest	Tons /acre		Tons C/acre
Rx fire + thin	1.8	8	0.07-0.7
Wildfire	1.4	2.7	0.03-0.3
Lodgepole pine forest			
Harvest + broadcast burn	4.5	6.3	0.09-0.9
Wildfire	4.5	14.4	0.15-1.5

- Charcoal forms at a rate of 1-10% of biomass consumed during a fire
- A **short** fire-return interval (ponderosa pine forests) can yield similar charcoal production rates as areas with a **longer** return interval (lodgepole pine) with more woody material on the soil surface.

CHARCOAL CHANGES AVAILABLE WATER CAPACITY

LET'S DO SOME MATH....

- IF: A ponderosa pine forest burned for the past 10,000 years with a fire return interval of 35 years (~285 fires) and
- AND: we generated 3% charcoal from each burn
- AND: Charcoal is 80% carbon
- THEN: there is approximately 32 tons/acre of carbon in the soil
- BUT: not all produced charcoal is sequestered
 - Erosion
 - Subsequent burning
- EXPECT about half of the charcoal to be belowground

HYPOTHETICAL C INCREASES WITH 2 OR 10 FIRES IN 200 YEARS

• ANOTHER EXAMPLE (YELLOWSTONE PARK)

- Standing biomass had 40 tons/acre carbon
- Charcoal formed at a rate of 8% for coarse wood (about 9 tons/acre on the ground)
- Yields about 1.5 tons/acre charcoal added in a single fire

REBURNS

2 reburns: 1988 and 2007; Canyon and Conger fires

CHARCOAL IN ONCE AND TWICE BURNED MIXED-CONIFER FORESTS: BOB MARSHALL WILDERNESS

CHARCOAL IN PONDEROSA PINE STANDS – 0-3 FIRES IN 130 YEARS: FRANK CHURCH AND SELWAY BITTERROOT WILDERNESS AREAS

RESTORATION TREATMENTS: FIRE-FIRE SURROGATE STUDY SITE IN MONTANA

From DeLuca et al., unpublished

SOIL TEXTURE IS IMPORTANT FOR WATER HOLDING

ARE YOU BURNING SLASH PILES?

- Build better slash piles
 - Big logs on the bottom
 - Light from the top
- Quench when the flames are gone
- Rake out the charcoal

IMPLICATIONS FOR FOREST MANAGEMENT

- Prescribed burns and wildfires can increase soil C
- The amount of C produced varies depending on past fires and harvesting operations
- Increased soil moisture from charcoal additions can:
 - Increase the quantity of stored water
 - Increased the quality of water downstream
 - Prevent erosion
 - Improve plant cover (green longer in the growing season)

SUMMARY

- Charcoal is a source of stable carbon
- Restoration thin + fire = 1-2 Mg charcoal/ha/burn
- Wildfire charcoal = 2-3 Mg charcoal/ha/burn
- Less charcoal/fire in a single hot fire
- Successive ground fires generate more charcoal
- Prescribed fires can restore charcoal levels in soil
- Amount of charcoal inputs depend on ecosystem type, fire severity, fire suppression, etc.
- Build resilient soils that hold more water longer into the growing season

