

# Changes in nitrogen availability, soil microclimate, and chip decomposition in mulching treatments in Colorado coniferous forests (JFSP 06-3-2-26)



Chuck Rhoades<sup>1</sup>, Mike Battaglia<sup>1</sup>, Monique Rocca<sup>2</sup>, and Michael G. Ryan<sup>1</sup>  
<sup>1</sup>U.S. Forest Service, Rocky Mountain Research Station, <sup>2</sup>Colorado State University

## Introduction

- Many areas in the Western U.S. are being treated to reduce wildfire hazard
- In some cases the biomass is shredded, chopped, or chipped and left on site (Fig. 1)
- These treatments have no natural analogue, so the effects of adding the woody material to the ecosystem is poorly understood
- The mulch layer may change the biogeochemical processes that regulate nutrient availability and ecosystem productivity (Fig. 2)
- Mulch layers affect both microclimate and inputs of water, nutrient, and carbon
- Plant demand for soil resources and the consequences of mulch application will likely differ between ecosystems



Figure 1

## Study Objectives

What are the effects of adding woody mulch on:

- 1) Soil climate
- 2) Mulch decomposition
- 3) Soil Nitrogen availability

Are effects consistent across ecosystems?

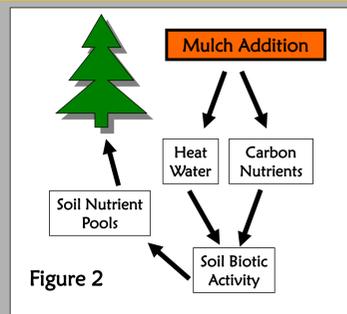
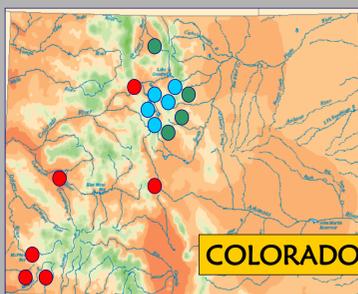


Figure 2

## Study Areas



Ecosystem	Annual PPT (cm)	Elevation (m)
Lodgepole	50	2600 – 2818
Ponderosa	40	2024 – 2350
Pinyon	33	1915 – 2400

## Sampling

**Operational Comparison**  
 Paired Mulched vs Untreated units  
 10 areas – 3 Ecosystems  
 3 transects (50-m) per study area

**Experimental Manipulation**

	Shallow vs. Deep Mulch	
PJ	1" (2.5cm)	3" (7.6cm)
PIPO	3" (7.6cm)	6" (15.2cm)
LPP	3" (7.6cm)	6" (15.2cm)

### Soil Climate

Soil temperature and moisture probes installed under mulch in the experimental manipulation

### Decomposition

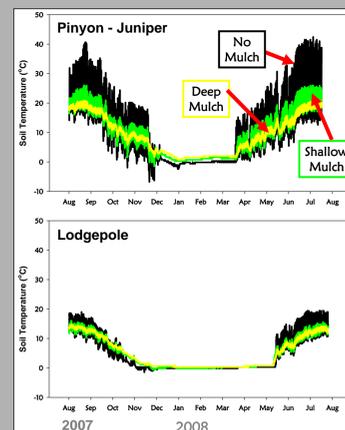
In each ecosystem, nylon screen bags filled with ponderosa pine chips and installed under mulch in the experimental manipulation

### Soil N Availability

Ion Exchange Resins installed in the Operational and Experimental Manipulation

## Soil Climate

Change in soil temperature ( C) compared to no mulch



### Summer Months

	Shallow	Deep
PJ Mean	-3.1	-4.6
PJ Max	-16.5	-21.5
PJ Min	-3.1	-4.2

### Winter Months

	Shallow	Deep
PJ Mean	+1.2	+1.9
PJ Min	+2.7	+3.2

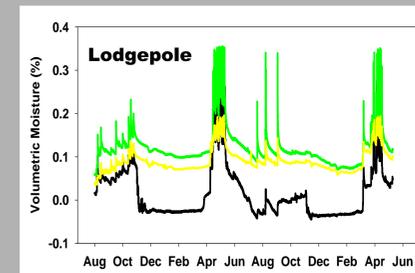
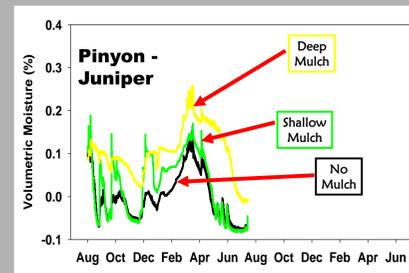
### LPP

	Shallow	Deep
LPP Mean	-1.0	-1.2
LPP Max	-3.8	-5.3
LPP Min	-4.1	-5.3

### LPP

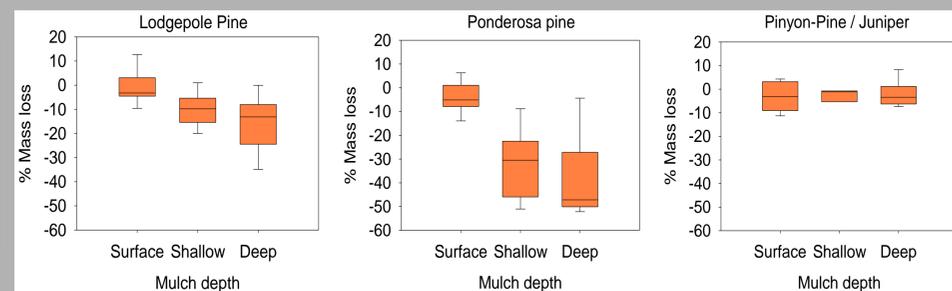
	Shallow	Deep
LPP Mean	+0.2	+0.4
LPP Min	+0.0	+0.5

- Cooler summer maximum
- Cooler summer temperatures
- Warmer winter minimums
- Warmer winter temperatures



- Mulched plots were generally wetter
- Mulched plots respond more to summer rain
- Effect of mulch depth maybe more important in PJ than Lodgepole

## Decomposition



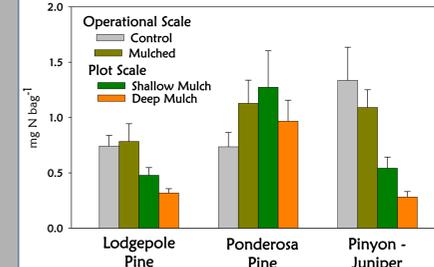
- After 2 years, there was virtually no change in the mass of the 'standard' ponderosa pine chips exposed on the soil surface
- In both the lodgepole and ponderosa pine ecosystems, chip mass loss was accelerated by burial beneath shallow or deep mulch
- In contrast, mulch bed depth had no effect on mass loss in the Pinyon pine – Juniper ecosystem

Questions? Please contact

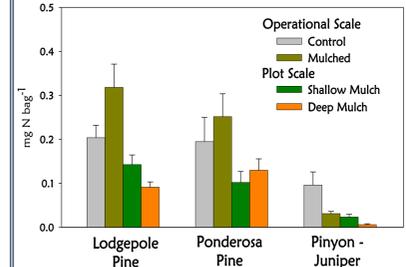
Chuck Rhoades ([crhoades@fs.fed.us](mailto:crhoades@fs.fed.us)) or Mike Battaglia ([mbattaglia@fs.fed.us](mailto:mbattaglia@fs.fed.us))

## Soil Nitrogen Availability

### Resin Nitrate



### Resin Ammonium



### Operational Application

- No Effect

### Operational Application

- No Effect

### Depth Effect

- Mulch decreases nitrate in PJ and Lodgepole ecosystems

### Depth Effect

- Mulch decreases NH<sub>4</sub> in PJ and Lodgepole ecosystems

### Shallow mulch

- ~60% decrease in PJ
- ~35% decrease in Lodgepole

### Shallow mulch

- ~76% decrease in PJ
- ~30% decrease in Lodgepole

### Deep mulch

- ~80% decrease for PJ
- ~57% decrease in Lodgepole

### Deep mulch

- ~94% decrease in PJ
- ~55% decrease in Lodgepole

## Summary

### Soil Climate

- Mulch additions reduced soil temperature and increased soil moisture during summer months
- Mulch dampened summer soil temperature fluctuations

### Ecosystem – Specific Responses

- The effect of mulch additions differed among ecosystems
- Resin N – was reduced in shallow and deep mulch beds for lodgepole and PJ, but not ponderosa pine ecosystems
- Chip decomposition – was faster in shallow and deep mulch beds for lodgepole and ponderosa pine, but not PJ ecosystems

### Resource limitations may explain Ecosystem Differences

- Reduced soil N in PJ and lodgepole pine ecosystems likely result from N immobilization within mulch beds
- In the ponderosa pine ecosystem, chips decay fastest and soil N pools do not decline
- Climate limitations – inhibit decomposition and favor microbial immobilization over mineralization in PJ (hot, dry) and lodgepole (wet, cold)
- Moderate soil nutrient and climate conditions – favor chip decomposition and N release in mulched ponderosa pine ecosystems