Red Mountain Mastication Study: southern Sierra Nevada

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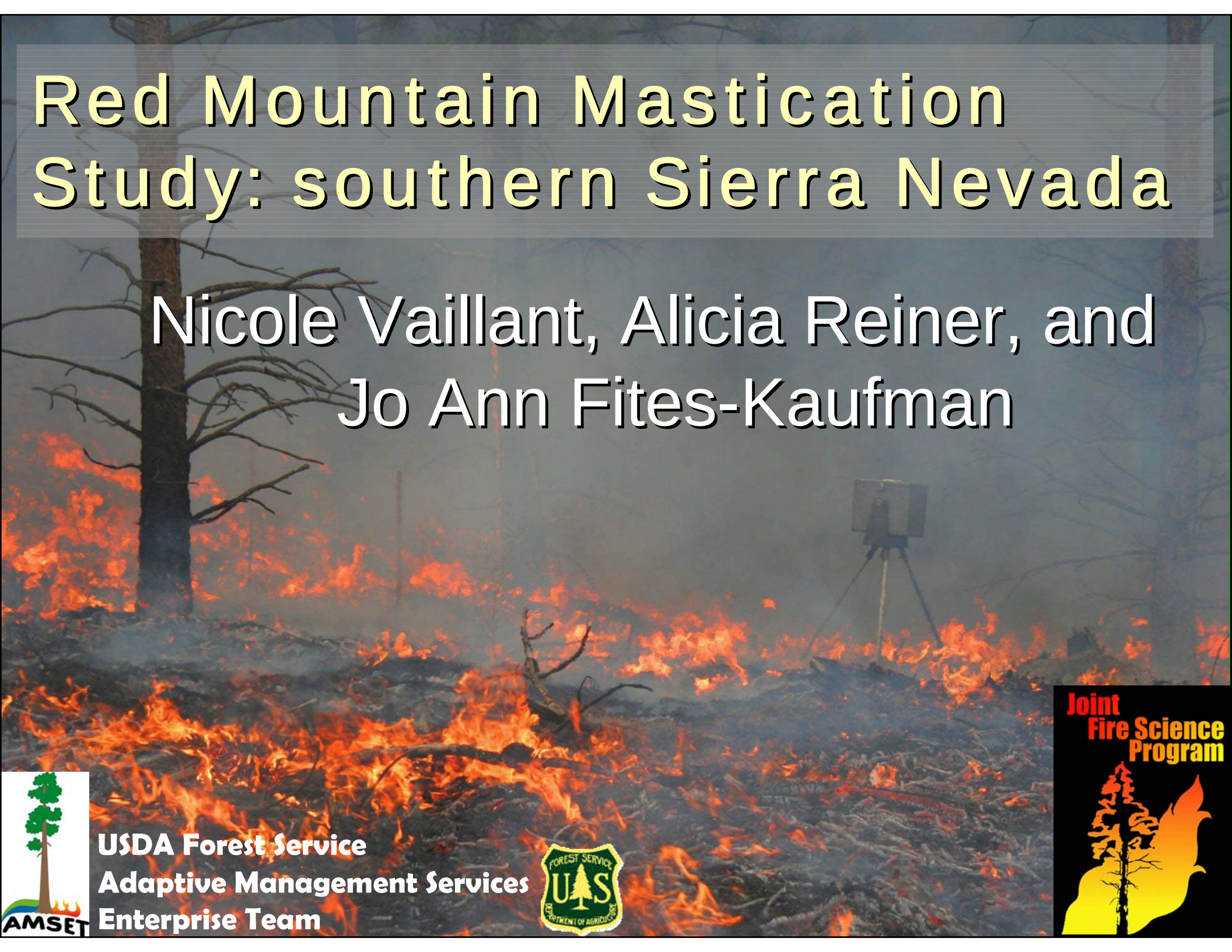


Background

- Mastication has become a more readily used tool to treat hazardous fuels
- It shreds ladder fuels (shrubs and small trees) increasing canopy base height and reducing canopy bulk density
- But the fuels are displaced to the surface layer
- The increase in surface fuels has the potential of creating more severe fire behavior
  - Higher intensity
  - Higher heat output and residence time

Project objectives

1. Determine the effectiveness of using mastication alone or mastication in combination with prescribed burning
   a. Fuels conditions
   b. Fire behavior
2. Quantify effects of mastication and mastication with prescribed burn treatments on tree mortality

Objective 1a

1) Estimate pre- and post-treatment canopy, live understory, surface and ground (litter and duff) fuel loads, and
2) Develop on-site bulk densities for masticated and ground fuels for use in estimating fuel loads

Study site

- Greenhorn Ranger District on the Sequoia National Forest
- Southern Sierra Nevada
- Red Mountain fuel treatment area
  - Burned in 1970
  - Planted with ponderosa pine
- Elevation: 1600 - 2000 m
- Slope: typically < 30%

Study site

- Ponderosa pine plantation with 10 m tall densely packed trees – some open areas
  - Also incense cedar, California black oak, white fir & sugar pine

- Some green leaf manzanita, Sierra goose berry, mountain mahogany, and annual and perennial grasses and forbs

Study design

- Random block design
- 4 blocks divided into 4 treatments with 4 plots each (64 total)
  - No treatment (control) - 2005
  - Masticate - 2006
  - Masticate then burn - 2007
  - Masticate, pull back, and burn - 2007
- Not all areas were treated => unbalanced

Study design

Number of plots per treatment type and year (s) data collected

Treatment	Pre-treatment 2005	Post-mastication, Pre-burn 2006	Post-treatment 2008
Masticate	7	7	7
Masticate/burn	11	11	11
Masticate/pull-back/burn	8	8	8
Control	16	0	16

Data collection

- Nested circular plots to collect tree data
  - Species, tag, DBH, canopy base height, height, crown position
- Main transect (15 m)
  - Fuel counts (natural & mast.) & depths
  - Understory vegetation (1 m belt) Burgan & Rothermel's method
- 5 Masticated quadrats (1x1m)
  - Depth & counts
- Masticated samples (30x30 cm frame)

Data analysis

- Canopy characteristics calculated using Fuels Management Analyst (FMA Plus)
- Biomass of live understory fuels calculated with BEHAVE
- Surface fuel loads calculated using species specific coefficients
- Site specific regressions created for litter, duff, and masticated fuel loads
- Fuel load data were analyzed using PROC GLIMMIX in SAS

Surface fuels

Year	Treat	1 h	10 h	100 h	1000 h
			(Mg ha^{-1})		
2005	M	0.19	0.79	0	17.4
	MB	0.04	1.44	1.50	14.1
	MPB	0.05	0.43	1.02	13.9
	C	0.02	1.08	2.08	52.1
2008	M	0.22	1.38	0	57.4
	MB	0.05	0.06	0.26	3.4
	MPB	0.02	0.43	0	0
	C	0.05	1.35	1.22	21.2

- High variability – no statistically sig. differences
- M increased all but 100 h
- MB & MPB reduced or had little change
- C variable

Canopy fuels

Year	Treat.	Canopy base height (m)	Canopy bulk density (kg m^{-3})
2005	M	0.6 (0.1)c	0.092 (0.009)
	MB	1.0 (0.2)c	0.120 (0.013)
	MPB	1.1 (0.2)c	0.124 (0.011)
	C	0.9 (0.2)c	0.110 (0.019)
2008	M	1.8 (0.3)bc	0.057 (0.006)
	MB	6.5 (0.6)a	0.055 (0.009)
	MPB	5.5 (0.8)ab	0.062 (0.01)
	C	1.0 (0.2)c	0.111 (0.012)

Same letter = NOT significantly different

No difference in CBH pre-treatment

Post-treatment CBH higher for MB & MPB than pre-treat.

No significant differences in CBD

Ground & understory fuels

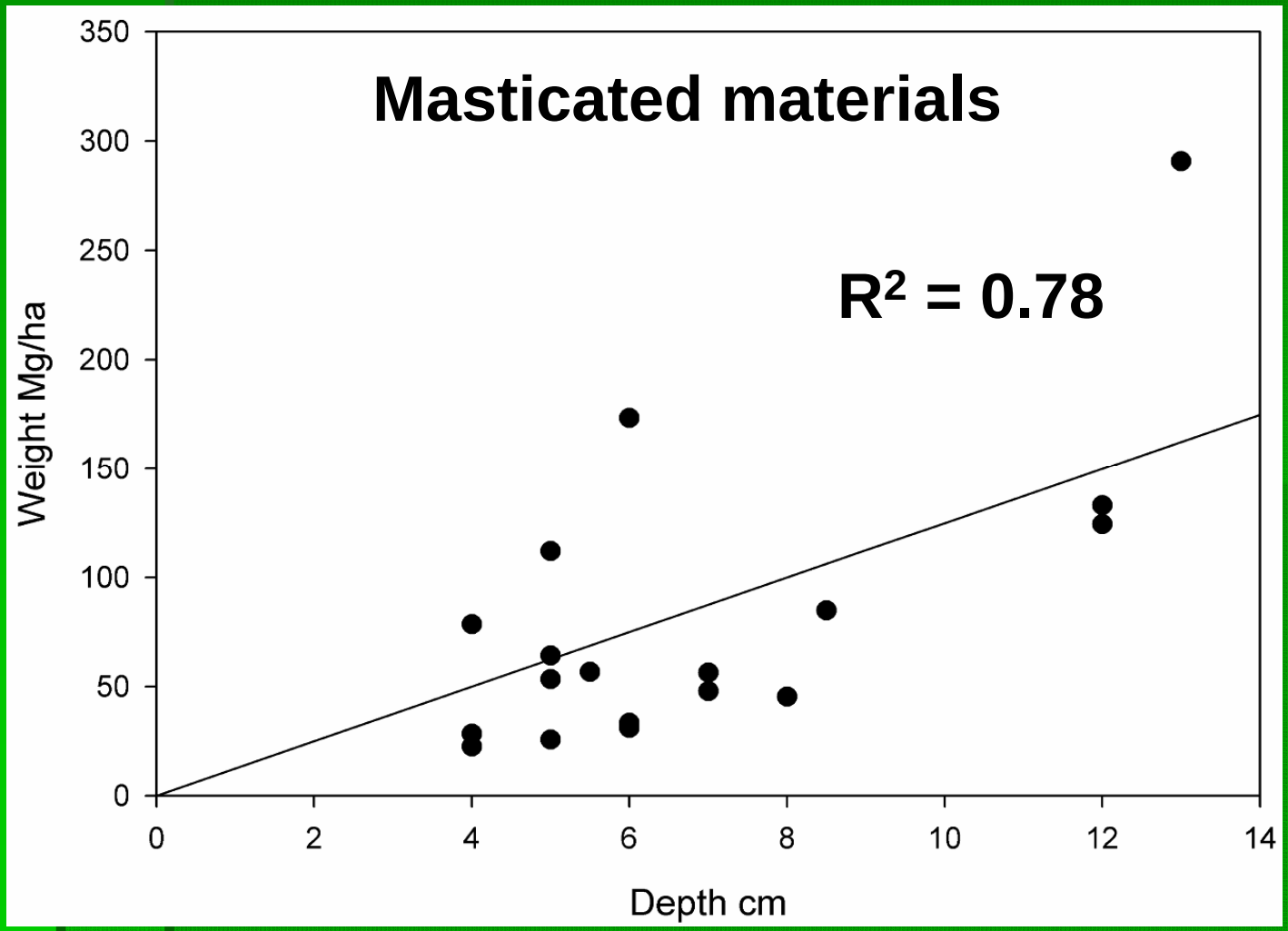
Year	Treat	Fuel depth	Litter	Duff	Understory
		(cm)		(Mg ha^{-1})	
2005	M	6.6ab	1.3	24.3	0.026
	MB	4.3ab	0.9	21.4	0.022
	MPB	4.8ab	1.4	26.4	0.034
	C	8.7ab	1.5	23.8	0.004
2008	M	25.7a	2.1	20.4	0.115
	MB	3.7b	0.7	0.8	0.035
	MPB	3.3b	0.7	2.0	0.137
	C	10.2ab	2.2	20.4	0.010

Same letter = NOT significantly different

M and MB reduce fuel bed depth

High variability again

Depth-to-weight regression



- High correlation between depth & weight for masticated materials
- Depth measures might be an easier way to characterize masticated fuel loads

Take home

- Generally mirrored past research
  - Increased in surface fuel loads with mastication only, and decreases with burning
- Care should be taken when using only mastication because it can create a continuous fuel layer
  - Possibly increasing potential fire behavior

Take home

- Characterizing masticated fuel loads is an important step to understanding fire behavior
- Anecdotal evidence suggests that rate of spread and intensity might be much higher than anticipated and could lead to dangerous situations

What's next?

- Characterize pre- and post-treatment fire behavior using FMA Plus
  - Custom fuel models vs. stylized
- Validate fuel models with fire behavior data and weather from the prescribed burn
  - Simplistic comparisons for ROS, and flame length
- Effect of treatments on mortality
  - Hope to get at least one more year of data collection
  - Lots of scorch, minimal torch, many trees still alive after 1 year...

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