Surface fuels in mulch treatments in Colorado's coniferous forests

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Mulching treatments redistribute the standing biomass from the vertical to the horizontal

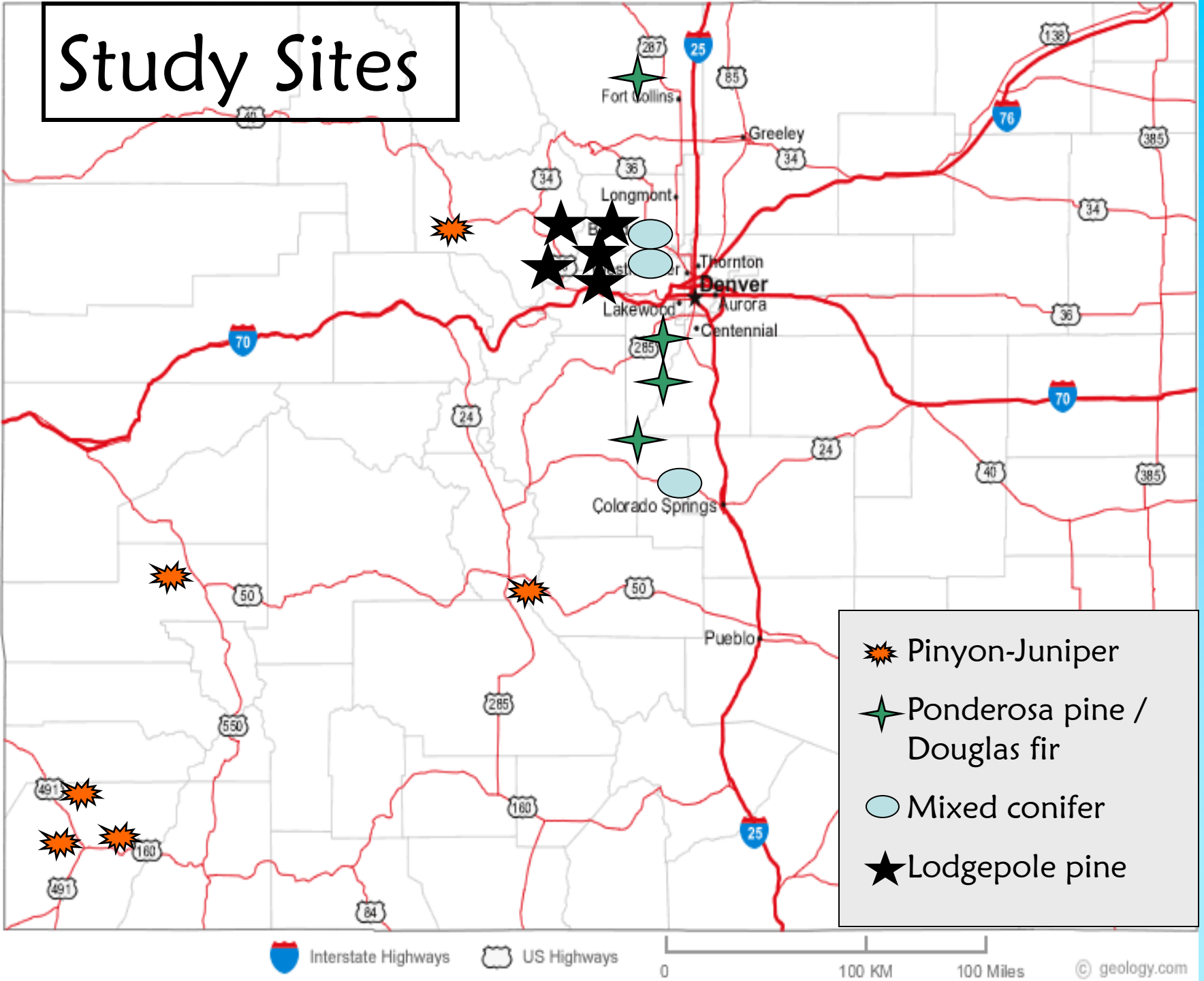
Grinding or chipping trees (usually smaller diameter) in place and scattering the wood

Quantify changes to forest floor

- Substrate Cover
- Fuel loadings
- Fuel size distribution
- Develop equations

Ecosystems studied

Study Sites


Fort Collins
Greeley
Longmont
Thornton
Denver
Aurora
Lakewood
Centennial
Colorado Springs
Pueblo
Pinyon-Juniper
Ponderosa pine / Douglas fir
Mixed conifer
Lodgepole pine
Interstate Highways
US Highways
0
100 KM
100 Miles
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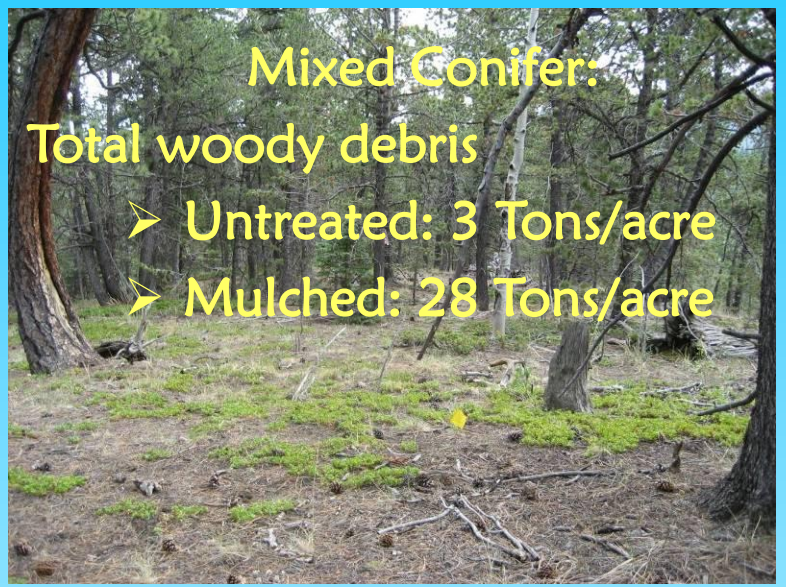
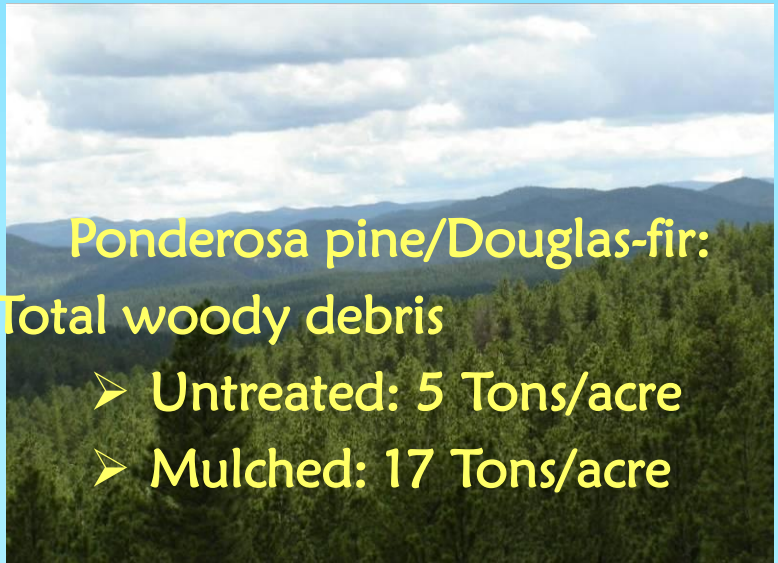
Methods

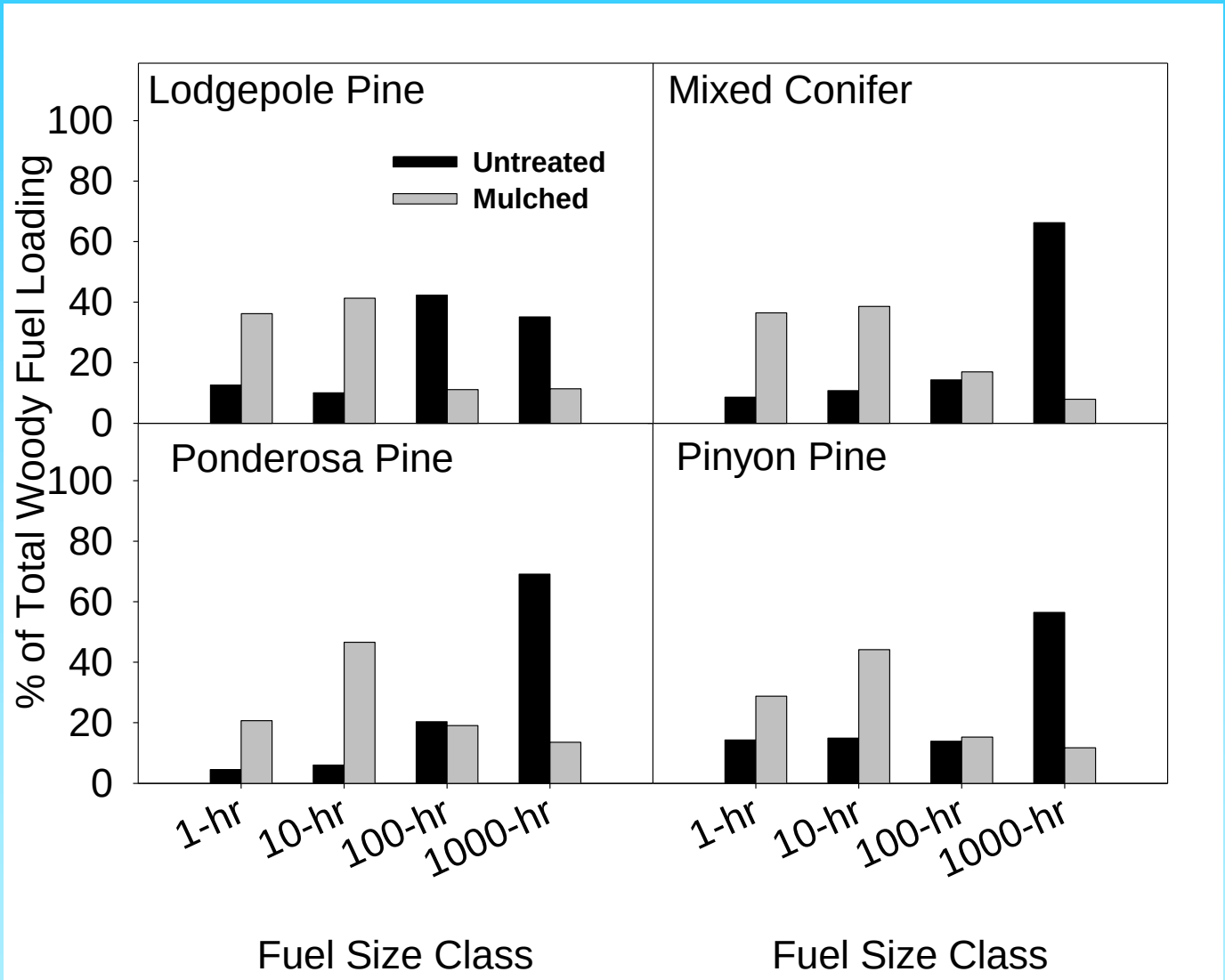
- Paired mulched and untreated sites
- sampled 2 to 4 years after treatment
- 3 150 ft transects per study area
- 25 10.76-ft^2 quadrats per transect

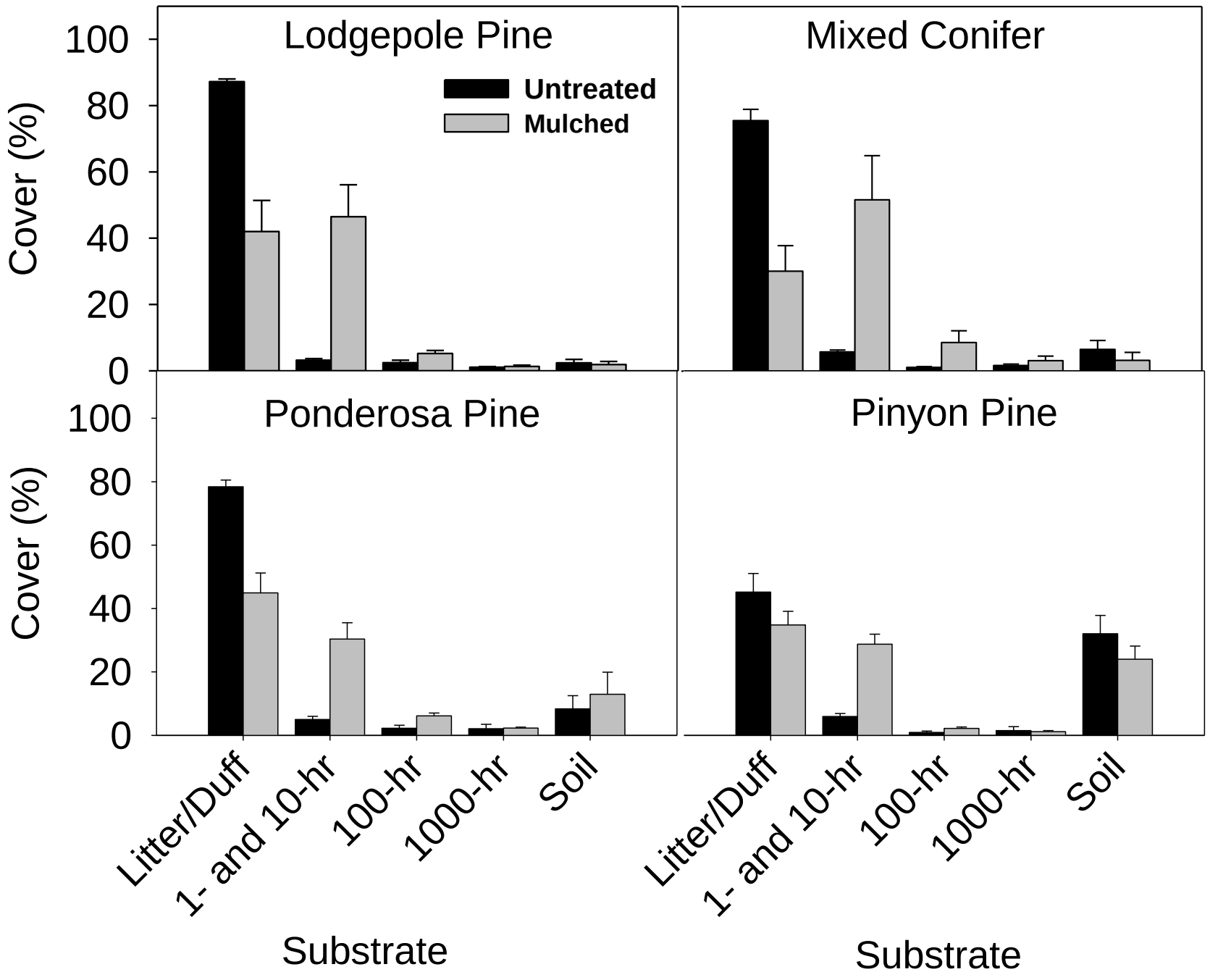
Surface fuel loads 3 to 4 times greater in mulched areas

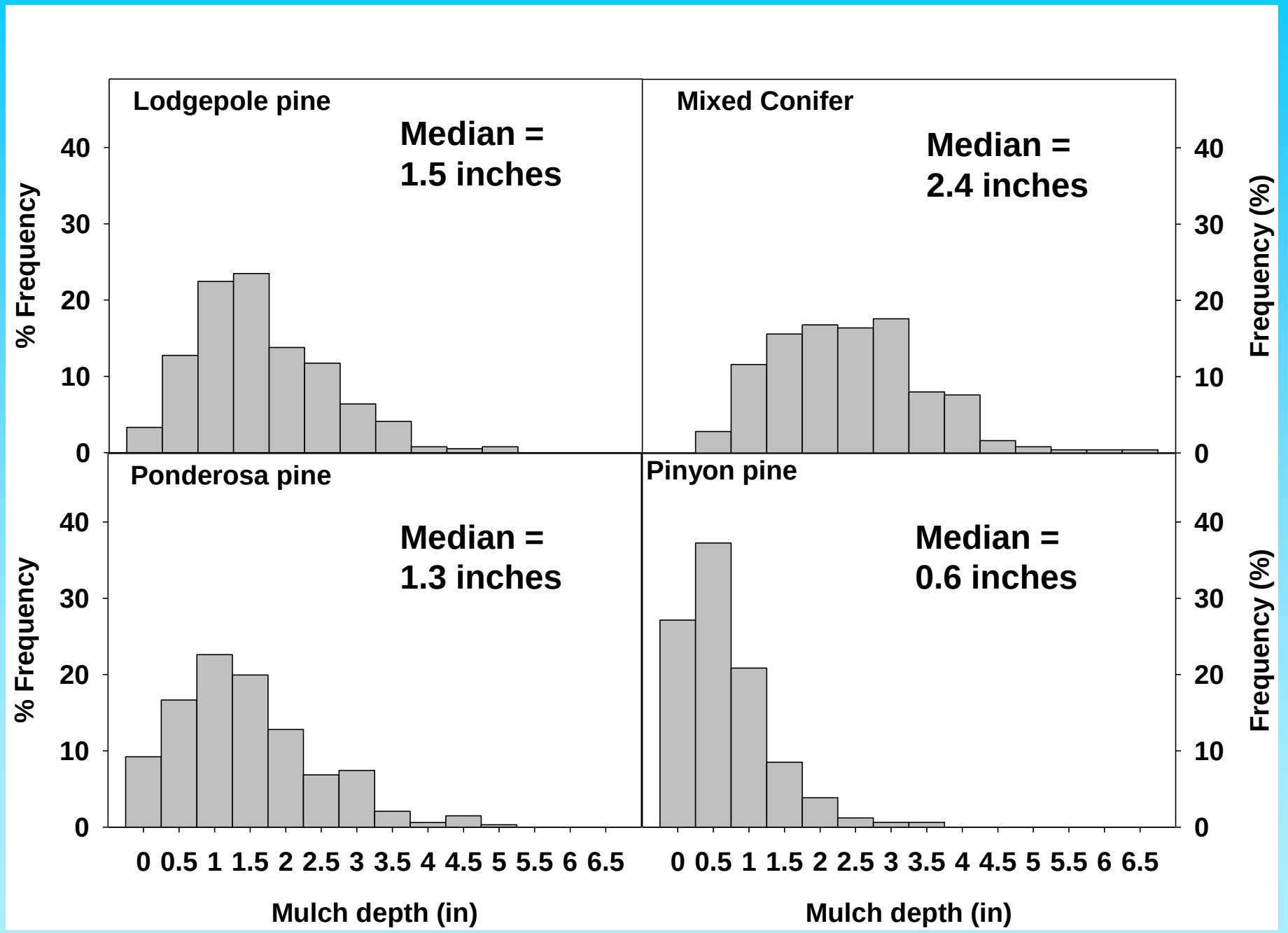




1 and 10 hr fuels contribute >70 % of total load in mulch treatments




Lodgepole Pine
Mixed Conifer
Ponderosa Pine
Pinyon Pine
Untreated
Mulched
Cover (%)
100
80
60
40
20
0
Litter/Duff
1- and 10-hr
100-hr
1000-hr
Soil
Substrate

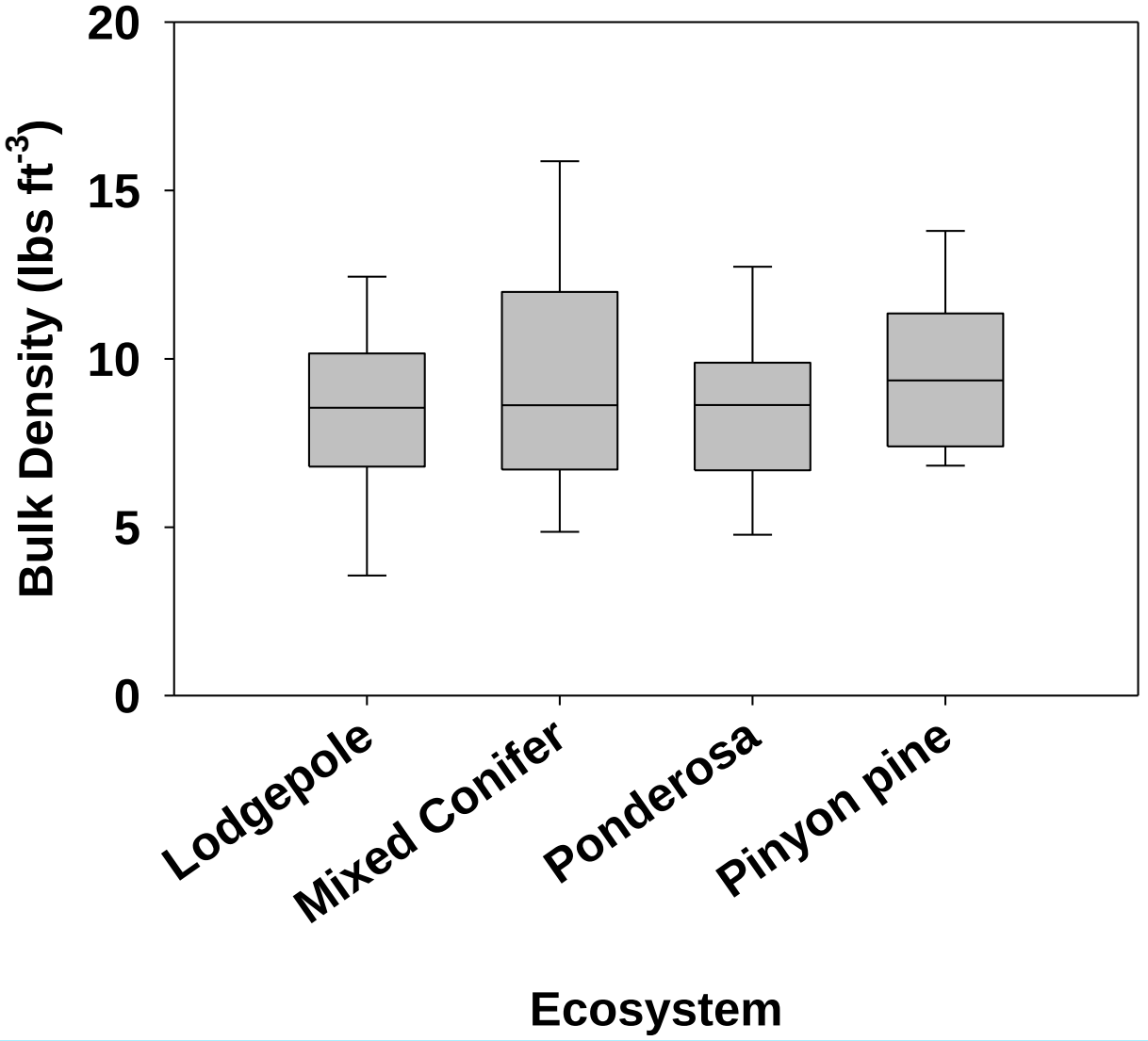

Lodgepole pine
Median =
1.5 inches
Mixed Conifer
Median =
2.4 inches
Ponderosa pine
Median =
1.3 inches
Pinyon pine
Median =
0.6 inches
% Frequency
Frequency (%)
0
10
20
30
40
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5
Mulch depth (in)

Mulching changes fuelbed characteristics

Ecosystem	Untreated Litter:Fine Woody Fuels	Mulched Litter:Fine Woody Fuels
Lodgepole	11.5	0.60
Mixed Conifer	20.6	1.2
Ponderosa	19.4	1.7
Pinyon Pine	5.6	1.2

Mulched fuelbed bulk density values indicate compact fuelbeds

Needle litter bulk density ~ 2 to 6 lbs ft^{-3}



Modeling potential surface fire behavior problematic

- Fuel beds differ in loading by fuel particle size
- Surface area-to-volume ratio of fuel beds differ
- Higher mineral soil content in fuel beds due to mixing and compression during operations

Observed vs Predicted fire behavior

- Limited number of studies (we haven't had the chance to observe yet)
- Custom fuel models, based on measured fuels, did not successfully predict observed fire behavior
- Observations:
  - Rate of spread and flame lengths are reduced
  - Flaming and smoldering duration increased

Sampling: Fuel load estimates

- At each study site 9 quadrats 10.76 ft^2 (1-m^2) in size established
- Measured total fuel depth at 5 points in quadrat


ACE
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Mulch fuel bed equations (litter + duff + 1 hr + 10 hr)

Ecosystem	Equation for Mulch Fuel bed mass (tons / acre)	r^2
Lodgepole	-1.721 + 17.04 *average_depth_inches	0.84
Mixed conifer	-7.435 + 20.48 *average_depth_inches	0.58
Ponderosa	-1.142 + 16.22 *average_depth_inches	0.86
Pinyon pine	-0.469 + 18.02 *average_depth_inches	0.90

Proportion of each fuel type in mulched fuel bed

Ecosystem	Litter	Duff	1-hr	10-hr
Lodgepole	0.18	0.20	0.29	0.33
Mixed conifer	0.29	0.20	0.25	0.26
Ponderosa	0.27	0.27	0.16	0.36
Pinyon pine	0.26	0.15	0.23	0.36

Mulch fuel bed= 0.478+ 0.796*tree biomass treated; $r^2 = 0.67$

Tree Biomass treated (tons/acre)	Mulch fuel bed [litter + duff+1hr + 10hr] (tons/acre)
10	8.4
20	16.4
30	24.3
40	32.3
50	40.3

So what's the average mulch depth you can expect?

Average mulch depth =

mulch bed mass ÷ Mulch fuelbed bulk density

For example,

If 20 tons/acre of tree biomass is treated, about **16.4 tons/acre** of **mulch** will be deposited on the forest floor.

Ponderosa pine mulch fuelbed bulk density = **8.65 lbs/ft^3.**

So what's the average mulch depth you can expect when treating 20 tons/acre of tree biomass?

Average mulch depth =

mulch bed mass ÷ Mulch fuelbed bulk density

= **16.4 tons/acre ÷ 8.65 lbs/ft^3**

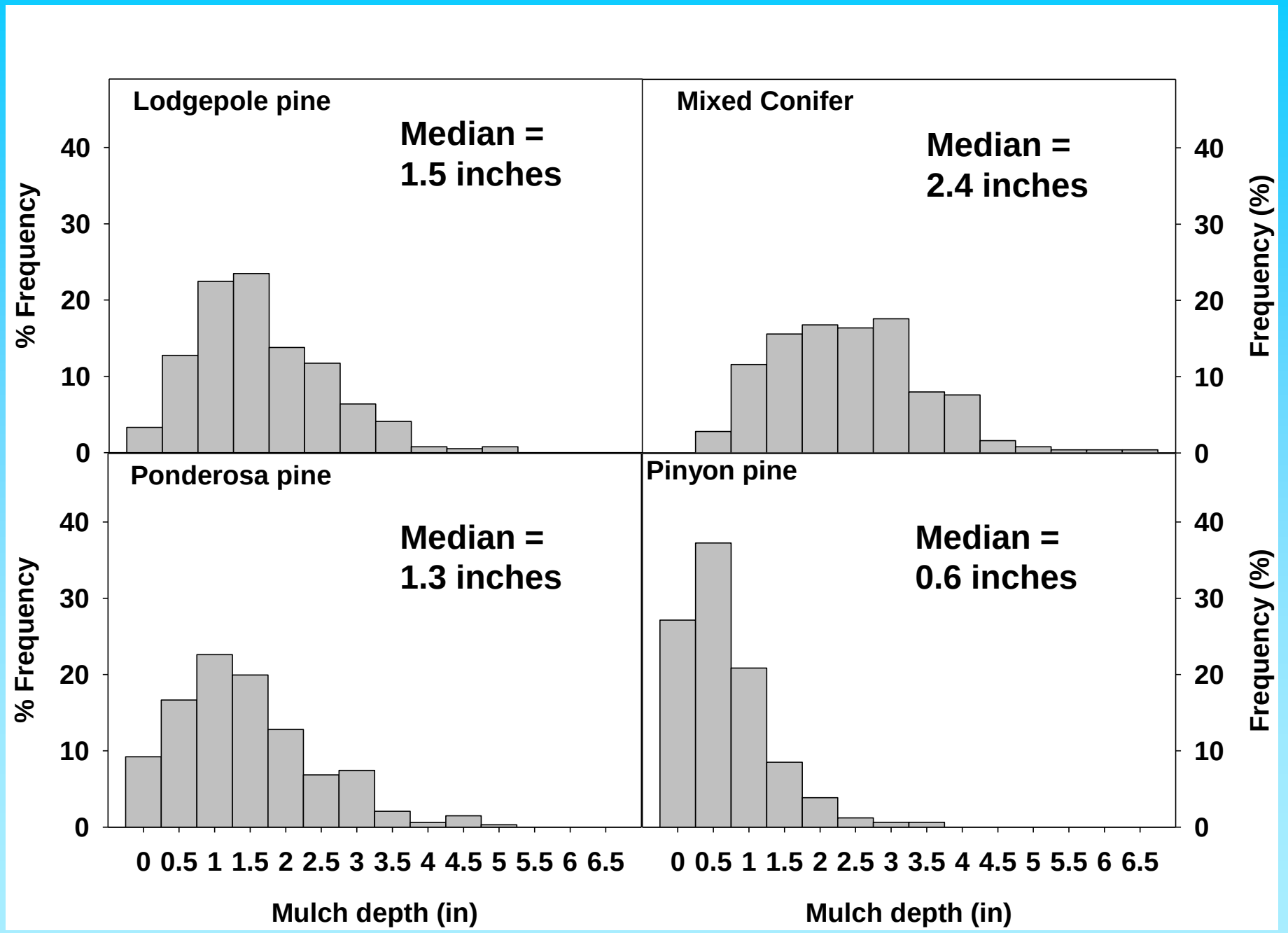
Note: (need to convert tons/acre to lbs/ft^2)

= 0.7530 lbs/ft^2 ÷ 8.65 lbs/ft^3 = 0.087 ft =

1.0 inch

Ponderosa pine example

Tree Biomass treated (tons/acre)	Mulch fuel bed [litter + duff+1hr + 10hr] (tons/acre)	Average depth (inch)
10	8.4	0.5
20	16.4	1.0
30	24.3	1.6
40	32.3	2.1
50	40.3	2.6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% Frequency
Frequency (%)
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10
20
30
40
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5
Mulch depth (in)

Take home messages: Fuels

- Surface woody fuel loadings in mulched treatments were elevated relative to untreated areas
  - About 3 to 4 times more fuel in mulched areas
  - Mostly concentrated in the smaller fuel size classes instead of the 1000-hr fuel size classes

- Mulch deposition was patchy, creating variability in mulch depth across sites, with many areas only receiving 0.5 to 2 inches of mulch

Take home messages: Fuels

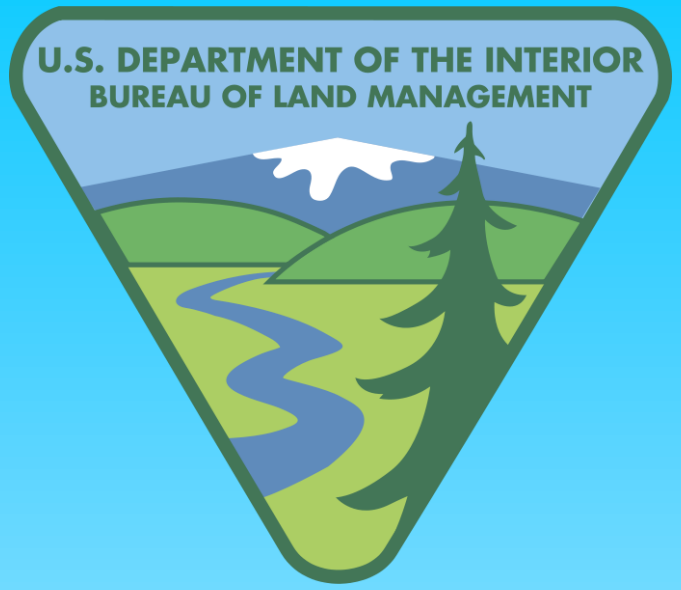
- Change in fuelbed characteristics
  - High bulk density = compact fuelbeds
  - Ratio of litter to woody fuels decreased = lower surface area to volume ratio

Take home messages: Fuels

- Change in fuelbed characteristics due to mulched treatments will change surface fire behavior
  - reduced rate of spread, shorter flame lengths, more smoldering, and possibly increased soil heating

Future work: Fuels

- Treatment longevity
  - Tree regeneration
  - Decomposition of woody fuels
- Development of fire behavior models
- Observations of fire behavior in mulched fuelbeds
- Mulched fuelbed susceptibility to firebrands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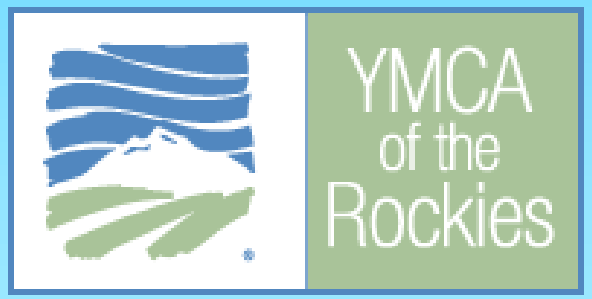
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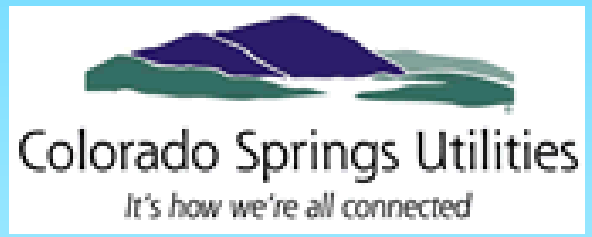
of the
Rockies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Questions?